september, 1960

nlgi spokesman

journal of the national lubricating grease institute

New Technique for Continuous Measurement of Grease Consistency During Manufacture

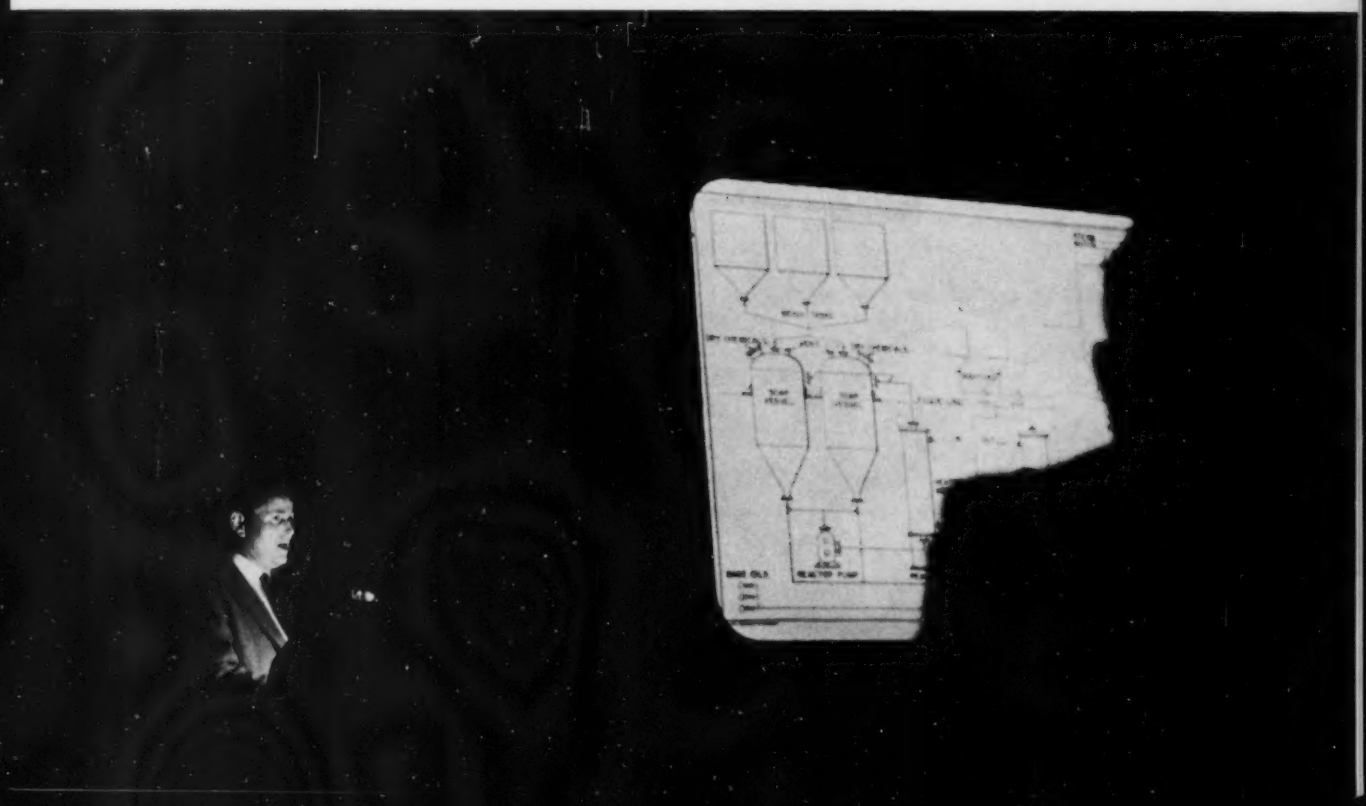
By J. L. DREHER and C. F. CARTER

Greases for Extreme Environments

By J. W. ARMSTRONG, J. R. HANDSCHY and D. E. LOEFFLER

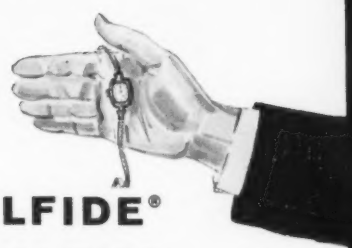
Background and Current Status of the API GL-4 Designation For Automotive Gear Lubricants

By C. R. NOLL



From a nuclear reactor...

to a delicate watch...



THE VERSATILITY OF MOLYSULFIDE® SOLVES MANY LUBRICANT PROBLEMS

On a nuclear reactor installation in England, it was proved that Molysulfide was the best lubricant to meet the exacting conditions of radiation and dry CO_2 at high pressure and temperature. Molysulfide in a resin carrier was baked on the ball- and roller-bearings used on the control rod mechanism of the reactor itself.

On the other hand, Molysulfide can be used in countless lubricants, from delicate watch parts to heavy-duty roll neck bearings . . . from self-locking nuts designed to withstand supersonic flight stresses to multi-purpose chassis greases.

There are five fundamental characteristics of Molysulfide which account for its unmatched excellence in lubricating applications:

- It has a very low coefficient of friction which decreases as load and sliding speed increases.
- It has a natural affinity for metal surfaces.
- It resists pressures far beyond the yield point of most metals.
- It is chemically stable.
- It performs over a wide temperature range from — 300 F to 750 F (over 2000 F in an inert atmosphere).

If you are faced with a tough lubrication problem, whether in research or in production, it will pay you to investigate the versatility of Molysulfide.

For a demonstration tube of Molysulfide, write Climax Molybdenum Company, 1270 Avenue of the Americas, New York 20, N. Y.

CLIMAX MOLYBDENUM

CLIMAX MOLYBDENUM COMPANY

a division of AMERICAN METAL CLIMAX, INC.

nlgi spokesman

Volume XXIV September, 1960 Number 6

Published Monthly by the National Lubricating Grease Institute, T. W. H. MILLER, Editor; VIRGINIA ALLEN, Assistant Editor, 4638 J. C. Nichols Parkway, Kansas City 12, Missouri. Telephone: VAlentine 1-6771. 1 Year Subscription, $5.00. 1 Year Subscription (Foreign), $6.00.

OFFICERS

President: H. A. MAYOR, JR., Southwest Grease and Oil Co., 220 W. Waterman, Wichita, Kans.

Vice-President: F. R. HART, Standard Oil Co. of California, 225 Bush Street, San Francisco, Calif.

Secretary: C. L. JOHNSON, Jesco Lubricants Co., P. O. Box 7331, North Kansas City, Mo.

Treasurer: A. J. DANIEL, Battenfeld Grease and Oil Corp., Inc., 3148 Roanoke Road, Kansas City 11, Mo.

DIRECTORS

W. W. ALBRIGHT, Standard Oil Co. (Indiana), 910 S. Michigan, Chicago, Ill.

S. C. M. AMBLER, British American Oil Co., Bay & College St., Toronto, Ontario, Can.

T. W. BINFORD, D-A Lubricant Co., Inc., 29th St. and Canal, Indianapolis 23, Ind.

E. W. CAMPBELL, Gulf Oil Corp., Gulf Building, Pittsburgh, Pa.

J. J. COATES, Esso Standard Div., Humble Oil & Refining Co., 34th and Smallman St., Pittsburgh 1, Pa.

R. CUBICCIOTTI, Sonneborn Chemical & Refining Corp., 300 Park Avenue South, New York, N. Y.

GEORGE LANDIS, Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.

J. W. LANE, Socony Mobil Oil Co., Inc., 150 E. 42nd St., New York 17, N. Y.

W. A. MAGIE, II, Magie Brothers Oil Co., 9101 Fullerton Avenue, Franklin Park, Ill.

G. E. MERKLE, Fiske Brothers Refining Co., 129 Lockwood Ave., Newark 5, N. J.

F. W. MINOR, Sinclair Refining Co., 600 Fifth Avenue, New York 20, N. Y.

W. M. MURRAY, Kerr-McGee Oil Industries, Inc., Kerr-McGee Bldg., Okla. City, Okla.

G. A. OLSEN, Sunland Refining Corp., P. O. Box 1512, Fresno, Calif.

F. E. ROSENSTIEHL, Texaco, Inc., 135 East 42nd Street, New York 17, N. Y.

W. H. SAUNDERS, JR., International Lubricant Corp., Box 390, New Orleans, La.

T. F. SHAFFER, Shell Oil Co., 50 West 50th Street, New York 20, N. Y.

Technical Committee Chairman: L. C. BRUNSTRUM, Standard Oil Co. (Indiana) Whiting Research Laboratory, Box 431, Whiting, Ind.

General Manager: T. W. H. Miller, NLGI, 4638 J. C. Nichols Parkway, Kansas City 12, Mo., VAlentine 1-6771

IN THIS ISSUE

President's Page 198

News About NLGI 200

Future Meetings 203

New Technique for Continuous Measurement of Grease Consistency During Manufacture 211
J. L. Dreher and C. F. Carter, California Research Corp.

Greases for Extreme Environments 215
J. W. Armstrong, J. R. Handschy and D. E. Loeffler, Shell Oil Co.

Background and Current Status of the API GL-4 Designation for Automotive Gear Lubricants 219
C. R. Noll, Gulf Oil Corp.

Literature and Patent Abstracts 224

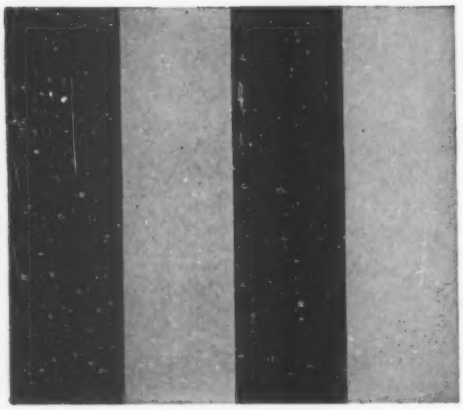
Industry News 232

People in the Industry 240

THE COVER

THE scene is familiar...a speaker illustrating his presentation with slides to an interested audience at an NLGI Annual Meeting. At this writing the largest number of speakers in the history of the Institute are preparing their talks and slides for the forthcoming session at the Edgewater Beach hotel, beginning October 30. "Expand Demand" is the theme and from the keynote address from a militant marketing expert right on through to the last technical paper, members and friends of the Institute will have a fact-packed three days on latest industry developments.

The NLGI SPOKESMAN is indexed by Industrial Arts Index and Chemical Abstracts. Microfilm copies are available through University Microfilm, Ann Arbor, Mich. The NLGI assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the NLGI. Copyright 1960. National Lubricating Grease Institute.



NLGI PRESIDENT'S PAGE

By H. A. MAYOR, JR., *President*

Plan NOW To Attend Annual Meeting

The big 1960 pay-off for those of us involved in NLGI activities will come when our hard-working program chairman and his committee launch the biggest Annual Meeting in the Institute's history with the Early Bird Reception on Sunday, October 30. Until the gavel raps the close of the Technical Committee session the following Wednesday, it will be a fast moving, interesting meeting.

There have been some interesting innovations woven into this year's schedule, each designed to better serve our membership. For the first time in NLGI history . . .

There'll be two concurrent sessions highlighting marketing and technical papers.

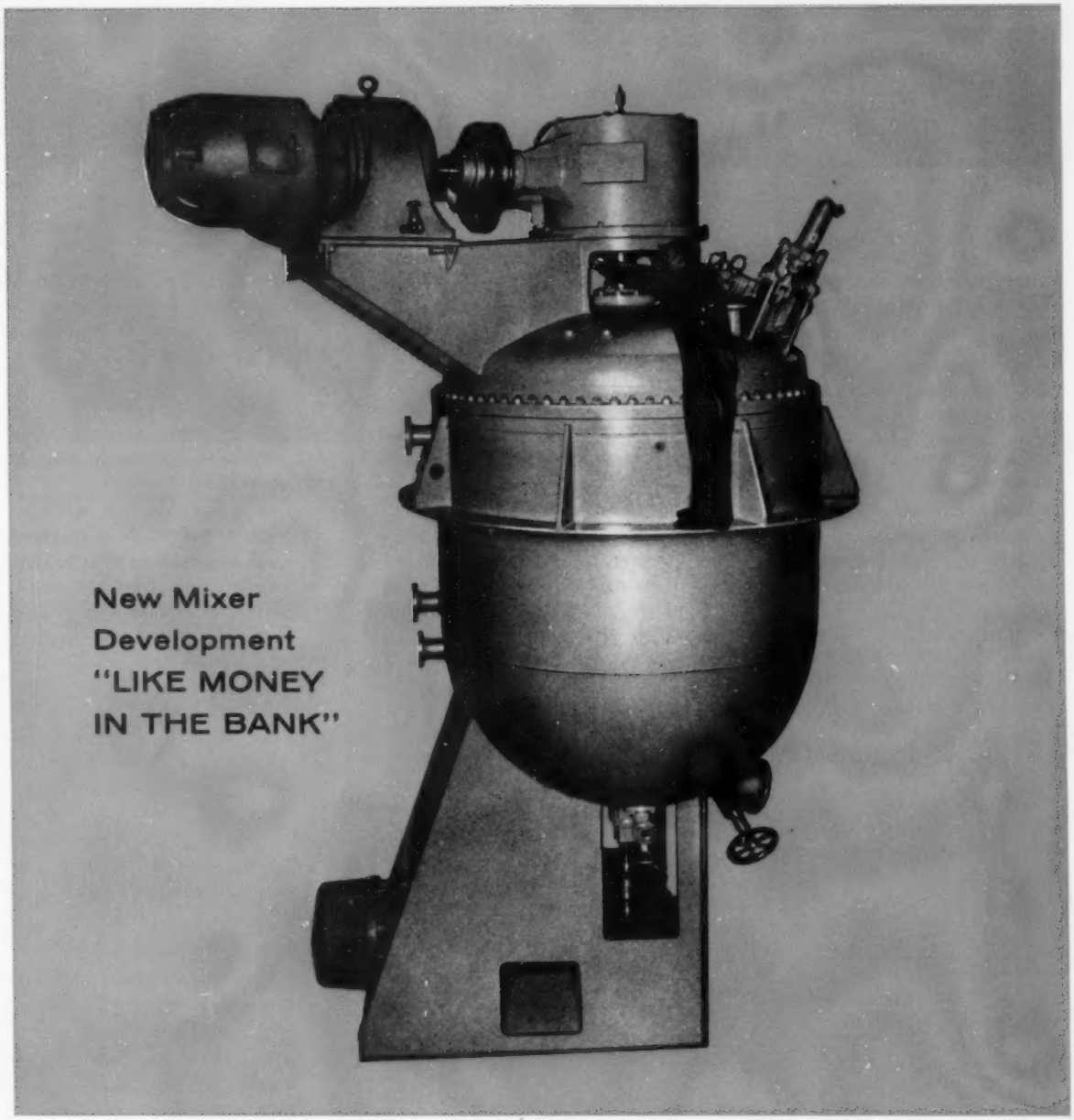
There'll be a general, Dutch Treat Monday luncheon for all those in attendance with no conflicting Board or Committee meetings scheduled.

The Annual Business Meeting will be held prior to the Monday, P.M. general session to promote better attendance and wider interest in the business affairs of our Institute.

There'll be pre-meeting and non-conflicting schedules for all Technical Sub-Committee activities.

The foundation for a successful meeting has been laid. Its success will be insured with your attendance so plan now to attend!

H. A. MAYOR, JR.
President



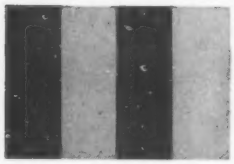
STRUTHERS WELLS CORPORATION
WARREN, PENNSYLVANIA
Plants at Warren and Titusville, Pa.

PROCESSING EQUIPMENT DIVISION
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels

BOILER DIVISION
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION
Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

This revolutionary "multi-action" grease mixer developed by Struthers Wells does the work of four "old type" machines . . . In service since 1957, it has been setting sensational production records and has achieved up to four times more efficient heat transfer . . . best of all, in terms of capital investment . . . it's money in the bank. Write for *Bulletin 581*



News About NLGI

Change Representatives

McCollister Grease and Oil of Omaha has named L. W. Okon as its representative to NLGI's Technical Committee from this Active member firm.

Witco Chemical of New York placed H. R. Spielman, assistant technical director of the organic chemicals division, as NLGI Company representative from this Associate member firm.

Baroid Chemicals of Houston, a subsidiary of National Lead, put Howard F. Sutter in as NLGI Technical representative from this Associate member firm.

Rheem Manufacturing of New York has named G. Gwyn Tucker as Company representative of this Associate member firm, replacing the late Mr. F. J. Blume.

Foote Mineral of Philadelphia has W. M. Raynor, general sales manager, filling both Company and Technical representative positions for this Associate member firm.

Core-Lube of Danville, Illinois, has put E. J. Patterson, grease production manager, as Technical representative of this Active member firm.

Climax Molybdenum of New York has moved K. B. Wood, manager of chemical sales, from Technical representative to the position of Company representative. W. M. Stilwell, manager of lubricant development, will now be Technical representative.

SERVICE AIDS

Send Orders to: National Lubricating Grease Institute, 4638 Nichols Pkwy., Kansas City 12, Mo.

NLGI GLOSSARY—A four-page booklet containing definitions of terms relating to the lubricating grease industry. Usable by marketing as well as technical people. Fifteen cents per copy (NLGI member price) and twenty-five cents (non-member).

BALL JOINT BOOKLET — "Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions." The latest aid in application, created by experts in the field and designed for use in the station. Twelve pages, easy to read, with large illustrations throughout. Twenty-five cents a copy with quantity discounts—company imprint arranged.

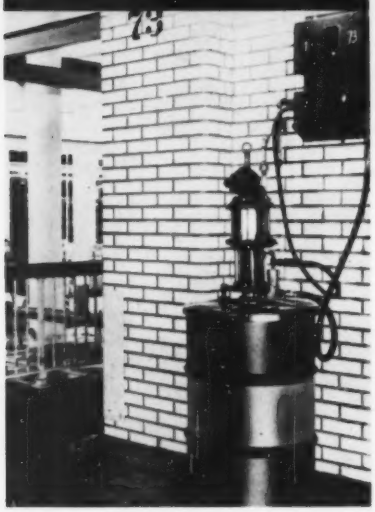
NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print $300, second and subsequent orders $200 each (non members add $100 to each price bracket).

WHEEL BEARING MANUAL — "Recommended Practices for Lubricating Automotive Front Wheel Bearings." More than 170,000 copies of this booklet have been distributed throughout the world. Now in its sixth printing. Sixteen pages, with more than 40 illustrations. Twenty-five cents a copy, with quantity discounts — company imprint arranged.

BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50, prepaid.

VOLUME XXII—Bound Volume of the NLGI SPOKESMAN from April, 1958, through March, 1959. Contains 31 articles and features dealing with lubricating greases and gear lubricants . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.

VOLUME XXIII—Bound Volume of the NLGI SPOKESMAN from April, 1959 through March, 1960. Contains 36 features on every phase of the lubricating and fluid gear lubricants industries . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.



From this central supply and control, pure lubricants are pressure-fed through sealed lines to injectors that deliver the right amount of lubricant at the right time to hundreds of lubrication points.

LINCOLN

Centralized Lubrication helps move Budweiser bottles by the millions

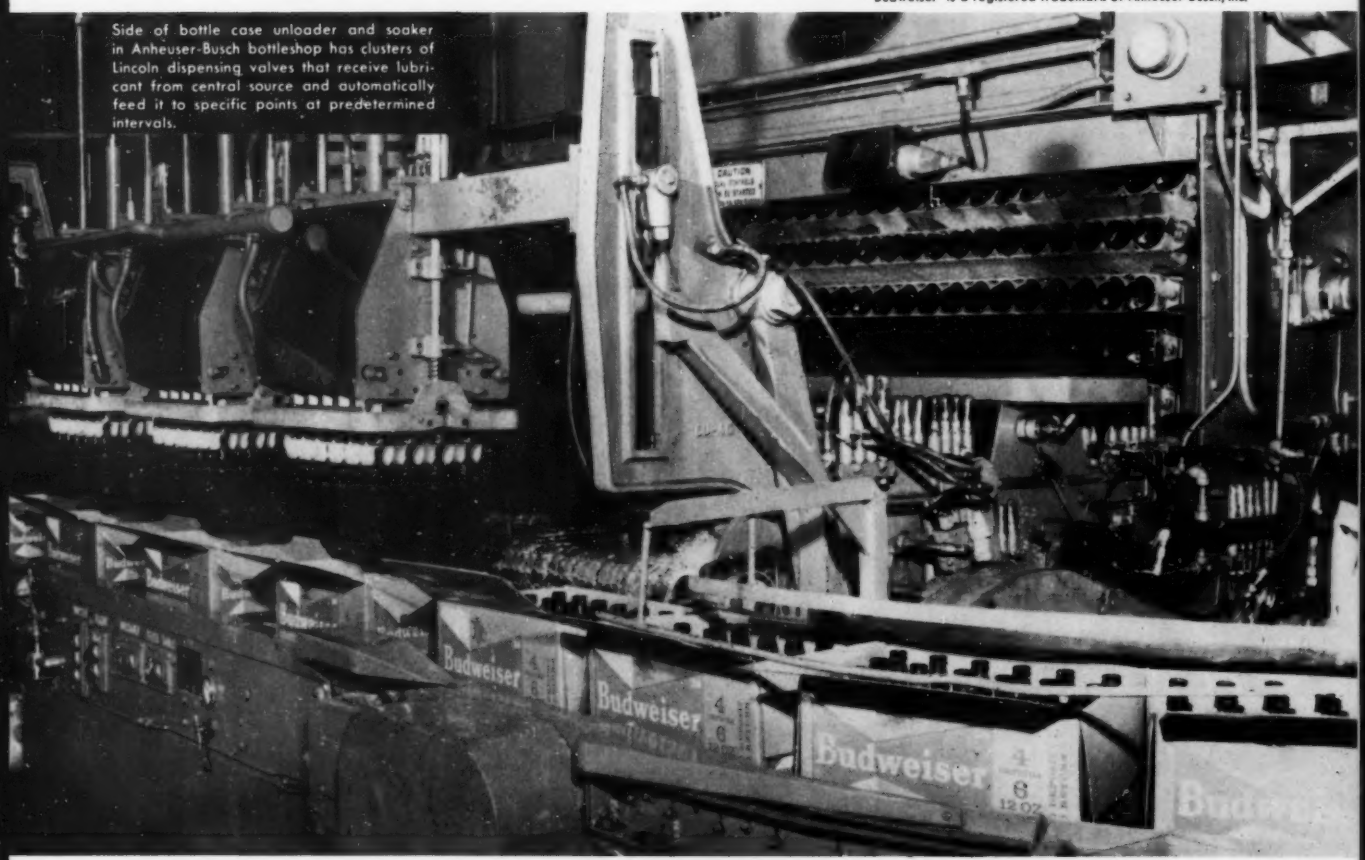
Millions of Budweiser* bottles pass through the soakers and sterilizers at Anheuser-Busch's St. Louis brewery—largest in the world. The hundreds of bearings in this automatic process must be correctly lubricated to keep a constant supply of containers moving in for refill.

Lincoln's Centralized Lubricating System looks after this job automatically, eliminating waste of manpower and lubricants, costly downtime, mechanical damage, and physical danger that threatens wherever machines are still oiled by hand.

Anheuser-Busch has used Lincoln systems for more than 20 years . . . another reason why *Lincoln is known by the companies it keeps.*

For information that can help you maintain high-speed production schedules in your plant, write today for complimentary copies of Catalog 81 and Lincoln's new centralized lubrication brochure, "A Report to Management."

*"Budweiser" is a registered trademark of Anheuser-Busch, Inc.

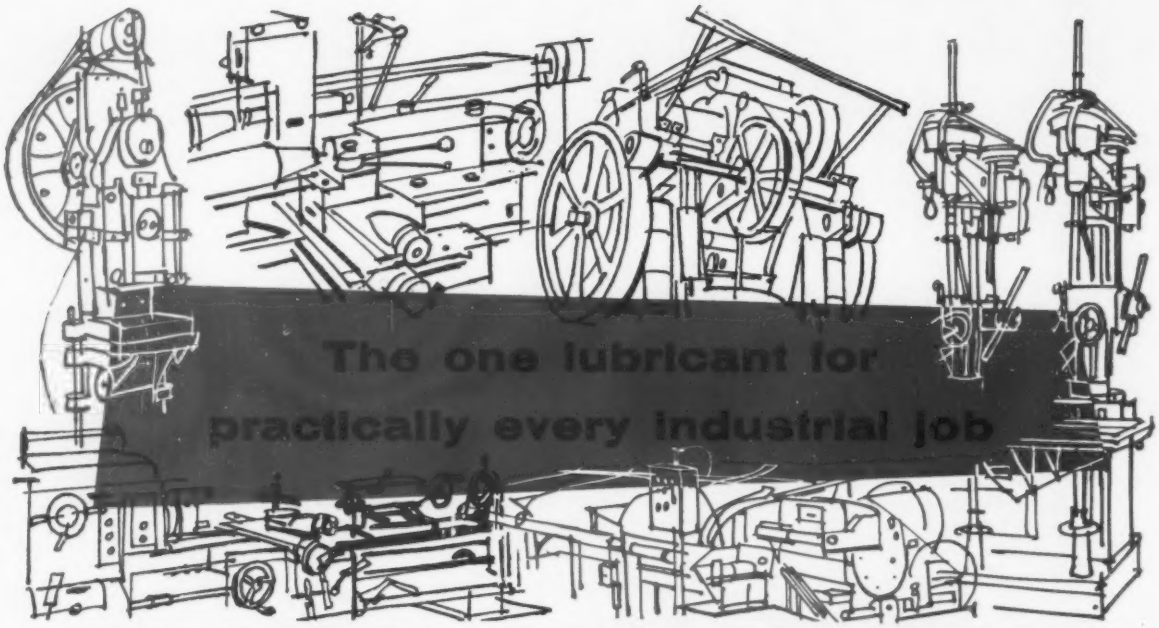


Side of bottle case unloader and soaker in Anheuser-Busch bottleshop has clusters of Lincoln dispensing valves that receive lubricant from central source and automatically feed it to specific points at predetermined intervals.

6040

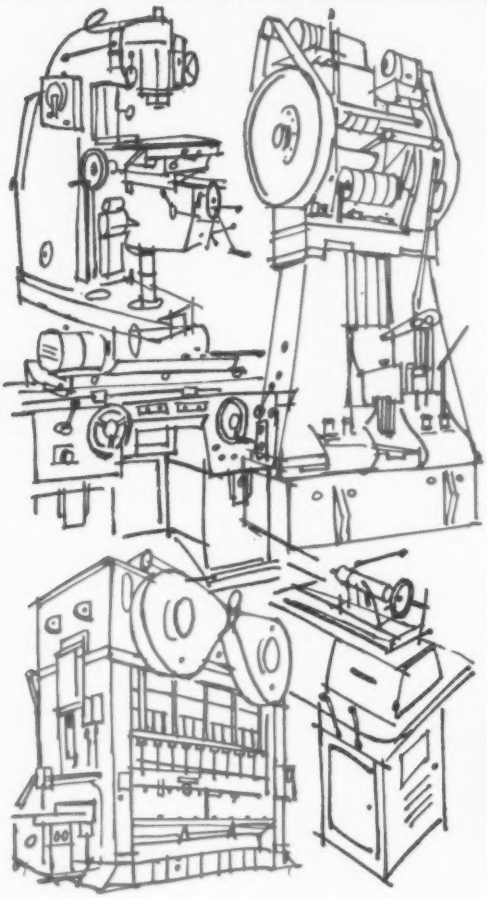
LINCOLN ENGINEERING COMPANY

DIVISION OF THE McNEIL MACHINE & ENGINEERING CO., 4010 GOODFELLOW BLVD., ST. LOUIS 20, MO.



ATLANTIC LUBRICANT 54

Performs on all types of grease-lubricated machinery • Cuts cost • Reduces lubricating errors



Atlantic Lubricant 54—an outstanding multi-purpose lubricant —assures:

- **Wider application**—almost universal application to grease-lubricated equipment in plants of all sizes
- **Excellent performance** at very high to extremely low operating temperatures
- **Reduced losses** from lubricating error
- **Lower costs** of warehousing and handling
- **Outstanding rust protection** for all ferrous surfaces
- **Unusual stability** against oxidation and softening—even under very rugged conditions
- **Easy, positive identification**—thanks to Atlantic Lubricant 54's distinctive purple color

Available from conveniently located warehouses. Call any of the Atlantic offices listed below.

ATLANTIC

LUBRICANTS • WAXES
PROCESS PRODUCTS

PHILADELPHIA, PA.
260 So. Broad St.

PITTSBURGH, PA.
Chamber of Commerce Building

PROVIDENCE, R.I.
430 Hospital Trust Building

SYRACUSE, N.Y.
Salina and Genesee Streets

CHARLOTTE, N.C.
1112 South Boulevard

In South America
Atlantic Refining Company of Brazil, Rio de Janeiro

Future Meetings

SEPTEMBER, 1960

11-16 American Chemical Society, 138th National Meeting, headquarters undecided, New York.

14 API Division of Marketing, lubrication committee meeting, Hotel Traymore, Atlantic City, New Jersey.

14-16 National Petroleum Association Annual Meeting, Hotel Traymore, Atlantic City, New Jersey.

18-20 IOCA 13th Annual Meeting, Hotel Moraine, Highland Park, Ill.

18-21 ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans.

OCTOBER, 1960

9-13 ASTM, Committee D-2 meeting, Mayflower Hotel, Washington, D. C.

10-12 API Division of Marketing, marketing research committee, Baker Hotel, Dallas.

17-19 ASME – ASLE Lubrication Conference, Statler Hilton Hotel, Boston.

OCT. 30 - NOV. 2 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago

NOVEMBER, 1960

2 Packaging Institute, petroleum packaging committee meeting, headquarters undecided, New York.

3-4 SAE National Fuels and Lubricants Meeting, Mayo Hotel, Tulsa, Okla.

14-16 API 40th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotels, Chicago.

15-17 Air Force–Navy–Industry Propulsion Systems Lubricants Conference (unclassified), Hilton Hotel, San Antonio, Tex.

27-Dec. 2 ASME Annual Meeting, Statler Hilton Hotel, New York.

JANUARY, 1961

9-13 Society of Automotive Engineers Annual Meeting, Cobo Hall and Convention Arena, Detroit.

FEBRUARY, 1961

5-10 ASTM Committee D-2 meeting, Benjamin Franklin Hotel, Philadelphia, Pa.

MAY, 1961

16-19 API Division of Marketing, Midyear Meeting, Americana Hotel, Miami Beach, Fla.

OCT. 29 - NOV. 1, 1961 NLGI Annual Meeting, Rice Hotel, Houston, Tex.

ADVANTAGES
of membership in the
National Lubricating Grease Institute

Some of the membership advantages are listed below:

- The NLGI represents over 95 per cent of the lubricating grease industry with members in this country and overseas.
- NLGI has a Technical Committee of 154 members which is divided into nine sub-committees working constantly on industry problems.
- The NLGI SPOKESMAN, a monthly technical journal, is mailed free of charge to key personnel within a member firm. If extra copies of the magazine are needed, they may be purchased at half the regular subscription price.
- The Institute works in close cooperation with affiliated groups including SAE, ASTM, ASA, ASLE, ASME, SAE-Cimtc and IOCA on problems and accomplishments in the lubricating field.
- The main objectives of the National Lubricating Grease Institute are for the development of better lubricating greases for the consumer and better grease lubrication engineering service to industry.

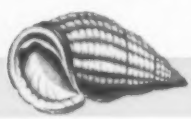
If your firm is interested in becoming affiliated with NLGI, the national office will be happy to furnish further information concerning the organization. Just as 1959 was a banner year for NLGI accomplishments 1960 promises to be even better with more scope and more member advantages.

Wherever in the world your industrial machinery operates...

Shell Alvania Grease is there

Other outstanding Shell Industrial Lubricants available world-wide

- **Shell Tellus Oils** – for hydraulic systems
- **Shell Talona R Oil 40** – anti-wear crankcase oil for diesel locomotives
- **Shell Rimula Oils** – for heavy-duty diesel engines
- **Shell Turbo Oils** – for utility, industrial and marine turbines
- **Shell Dromus Oils** – soluble cutting oils for high-production metalworking
- **Shell Macoma Oils** – for extreme pressure industrial gear lubrication
- **Shell Voluta Oils** – for high-speed quenching with maximum stability



AN INTERESTING FACT!
Every Shell Branded Industrial Lubricant is named for a sea shell. Shown here is the **Alvania** beanii.

Around the world, Shell Alvania Grease is available—under the same brand name and providing the same outstanding lubrication. This is assurance that your customers abroad will enjoy the same performance from your equipment that domestic customers rely upon.

Alvania® Grease offers these performance-proved advantages: (1) It provides safe lubrication at both high and low temperatures. (2) It won't wash out even in locations where water splashing can't be avoided. (3) It has built-in protection against rust and pitting of anti-friction bearings. And because this *one* multi-purpose grease is specially designed to satisfy as much as 90% of industrial grease needs, less servicing time is required; inventory costs are less; and there is less risk of misapplication.

No matter where your machinery is shipped, make Shell Alvania Grease your standard recommendation. Write for complete information.

SHELL OIL COMPANY

50 WEST 50TH STREET.....NEW YORK 20, N. Y.
100 BUSH STREET.....SAN FRANCISCO 6, CALIFORNIA
IN CANADA: SHELL OIL COMPANY OF CANADA, LIMITED
505 UNIVERSITY AVENUE.....TORONTO 2, ONTARIO

SHELL

NLGI 28th ANNUAL MEETING

October 30 — November 2, 1960

Edgewater Beach Hotel Chicago

Largest Annual Meeting in NLGI History

A record number of 25 presentations will be made at the next NLGI Annual Meeting . . . the highest in the history of the Institute. Covering the industry from every possible aspect, these papers deal with how to accomplish the theme of the session . . . how to "Expand Demand" for lubricating greases and fluid gear lubricants.

The 28th Annual Meeting will be held at the Edgewater Beach hotel in Chicago, beginning Sunday, October 30, through Wednesday, November 2, 1960.

Sales ideas, the farm machinery outlook, package trends, and the 1958 Food Additives Amendment are among the important talks marketing men will want to hear. There will also be an up-to-date report on lubricating grease requirements for the 1961 cars.

Technical men have had their sessions doubled in length because of the interest experienced at previous annual meetings. Permeability, structural changes, electron microscope examinations . . . these and other subjects will be pursued in concurrent meetings (for a complete listing, see page 209).

The business of the Institute will be conducted, too . . . with two board of directors meetings, the steering committee meeting and sessions by all of the subcommittees, the annual business meeting and the Technical committee meetings.

Social events begin with the first function of the Annual Meeting . . . the "Mr. and Mrs. Early Bird Reception" at six, Sunday evening, October 30. A new Dutch Treat luncheon will make its bow on Monday. Tuesday evening will be given over to the traditional Social Hour and Annual Banquet.

For a rewarding experience . . . to meet new friends and to greet old acquaintances . . . to learn the latest about your industry, we hope to see you in Chicago.

For a Listing of Tentative Titles and Speakers to be Presented in Chicago, Please Turn to Page 209 . . .

ENGINEERED PROTECTION...

. . . in every drop of Cato Lubricant

Maximum efficiency from machinery hinges on selection of the correct lubricant to do a job. Hundreds of greases and specialty oils, each with individual properties blended for a specific job, have been developed through constant research at Cato Oil and Grease Company. These lubricants, unsurpassed for quality, are available for packaging under your label. Development of "tailor-made" lubricants for new uses are our specialty. Expansion and modernization of our facilities, now nearing completion, has enabled us to offer you better service on any order from a few pounds to thousands of pounds.

CATO OIL AND GREASE COMPANY

Oklahoma City, Oklahoma

Better Greases Through BAROID RESEARCH

BARAGEL 24* provides greater stability in greases made from non-petroleum oils

BARAGEL 24, a non-soap grease-gelling agent, gives greater stability to greases made from such non-petroleum oils as polyalkylene glycols, di-2-ethylhexyl sebacate, di-2-ethylhexyl adipate and castor oil. The development of BARAGEL 24 is another result of Baroid Chemicals' research.

Greases compounded with BARAGEL 24 are subjected to the most rigid testing. One of these tests measures grease penetration over the range of unworked to 10,000 strokes. In non-petroleum based oils, BARAGEL 24 produces greases that are exceptionally stable to working in the ASTM grease worker. These greases show minimum breakdown under the most rigorous operating conditions.

BARAGEL 24 is a reaction product of organic ammonium halides and refined sodium montmorillonite. BARAGEL 24 is a member of the BARAGEL-BENTONE* family of products which has been used so successfully in greases, plastics, paints, inks and other fields.

*Trademark of National Lead Company for an organic ammonium montmorillonite

5074

BAROID

BAROID CHEMICALS, INC.

A SUBSIDIARY OF
NATIONAL LEAD COMPANY

1809 SOUTH COAST BUILDING
HOUSTON 2, TEXAS

Schedule of NLGI Annual Meeting Papers

General Sessions

PRESIDENT'S ADDRESS, *H. A. Mayor, Jr.*, Southwest Grease & Oil, Wichita.

KEYNOTE ADDRESS, *C. J. Guzzo*, senior vice-president, Gulf Oil, Pittsburgh.

SELLING THE LUBRICATING GREASE MARKET, *C. L. Johnson*, Jesco Lubricants, Kansas City.

WHY WIRE ROPE LUBRICANTS ARE SPECIAL COMPOUNDS, *R. O. Kasten*, Union Wire Rope, Kansas City.

NEW GREASE PLANT LAYOUT, *M. E. Erwin*, Gulf Oil, Port Arthur, Texas.

WHAT'S AHEAD IN FARM MACHINERY LUBRICATION, *W. A. Magie, Jr.*, Magie Brothers Oil, Franklin Park, Illinois.

A REVIEW OF NLGI FELLOWSHIP ACTIVITY, *L. C. Brunstrum*, Standard Oil (Indiana), Whiting, Indiana.

Marketing Sessions

NEW DEVELOPMENTS IN HIGH TEMPERATURE GREASE, *D. S. Barnes*, Standard Oil (Indiana), Whiting, Indiana.

AERO/SPACE GREASE REQUIREMENT TRENDS, *D. N. Harris*, Shell Oil, New York.

LUBRICATION OF NUCLEAR POWER PLANTS, *R. S. Barnett*, Texaco, Beacon, New York.

FUTURE PACKAGE TRENDS AND DESIGNS FOR LUBRICATING GREASES, *F. W. Langner*, Socony Mobil Oil, New York.

LUBRICATING GREASE REQUIREMENTS OF 1961 CARS, *H. Eldridge*, Chek-Chart, Chicago.

CENTRALIZED LUBRICATING SYSTEMS, *R. B. Yahn*, Yahn Engineering and Sales, Palmer, Mass.

A RAPID METHOD OF PREDICTING THE FLOW PROPERTIES OF GREASE, *C. F. Carter*, California Research, Richmond, California.

LESSONS TO BE LEARNED FROM THE CATO GREASE PLANT FIRE, *R. Jenks*, Cato Oil and Grease, Oklahoma City.

QUALITY CONTROL TESTS FOR USE IN GREASE PLANTS, *T. R. Welch*, British Petroleum, Middlesex, England.

1958 FEDERAL FOOD ADDITIVES AMENDMENT, *A. E. Dooley*, Texaco, New York.

Technical Sessions

THE PERMEABILITY OF LUBRICATING GREASE, *A. W. Sisko*, Standard Oil (Indiana), Whiting, Indiana.

STRUCTURAL CHANGES AND PHASE TRANSITIONS IN LITHIUM GREASES, *A. M. Suggitt*, Texaco, Beacon, New York.

ELECTRON MICROSCOPE EXAMINATION OF THIN FILM SECTIONS OF LUBRICATING GREASE, *J. W. Wilson*, Socony Mobil, New York.

A RHEOLOGICAL EQUATION FOR GREASES, *E. O. Forster*, Esso Research and Engineering, Linden, New Jersey.

OXIDATION OF LUBRICATING GREASES, *J. E. Goodrich*, California Research, Richmond, California.

INDUSTRIAL EXTREME PRESSURE GEAR LUBRICATION, *D. W. Dudley*, General Electric.

THIXOTROPIC BEHAVIOR OF GREASE, *Kak-Choong Kim*, NLGI Fellow at the University of Utah, Salt Lake City.

REPORT ON FELLOWSHIP ACTIVITIES, *E. L. Armstrong*, Socony Mobil, New York.

OTHER ANNUAL MEETING HIGHLIGHTS include subcommittee meetings, Steering Committee action, the Annual Business meeting, and the NLGI Technical Committee meeting.

NLGI 28TH ANNUAL MEETING, EDGEWATER BEACH HOTEL, CHICAGO, OCTOBER 30—NOVEMBER 2, 1960. REGISTRATION FIVE DOLLARS (MEMBERS) AND TEN DOLLARS (NON-MEMBERS), BANQUET TEN DOLLARS AND SOCIAL HOUR THREE DOLLARS. FOR FURTHER INFORMATION PLEASE CONTACT: NATIONAL LUBRICATING GREASE INSTITUTE, 4638 J. C. NICHOLS PARKWAY, KANSAS CITY 12, MISSOURI. (PHONE) VALENTINE 1-6771. T. W. H. MILLER, GEN. MGR.

Baker does it all

There's no middle man in the picture when you buy your hydrogenated castor oil derivatives from Baker. Because, from selection of the raw castor beans to production of the finished chemicals, Baker does it all.

This integrated operation assures you of uniform quality and steady supply of Baker's Castorwax® hydrogenated castor oil, hydroxystearic acid, and methyl hydroxystearate. It also means that by the bag or carload, Baker—the world's largest and most experienced producer of castor oil derivatives—is your prime source of supply.

Let us fill your next requirement. We will deliver what you need when you want it. Baker plants at Bayonne and Los Angeles, offices and warehouses in principal cities.

7401-A

the Baker ESTABLISHED 1857 castor oil company

BAYONNE, NEW JERSEY

Manufacturing Symposium—IV

(Conclusion)

New Technique for Continuous Measurement of Grease Consistency During Manufacture

By: J. L. Dreher and C. F. Carter

California Research Corporation

Presented at the NLGI 27th annual meeting in New Orleans, October, 1959

THE MANUFACTURE of a soap-base grease usually starts with the preparation of a concentrate of soap and oil. The concentrate is "mixed off" with additional oil to produce a finished lubricating grease with the desired consistency. The degree of dispersion of the soap in the finished grease is related to the consistency of the concentrate during the mixing off. If the concentrate is too soft, more soap may be required to make grease of a given grade; if it is too hard, circulation in the mixer may be inadequate or the mixer may be overloaded. Part of the art remaining in grease manufacture is the "feel" for the optimum consistency for efficient mixing. The addition of oil and the rate of cooling are regulated to obtain what is considered to be the desired consistency.

In order to obtain a quantitative indication of the consistency of the grease during processing, a new laboratory grease mixer with a magnetic clutch for measuring torque was recently designed and constructed at California Research corporation. This paper describes the magnetic clutch torque system and the resultant refinements in grease making techniques. It illustrates the benefits resulting from the equipment. Additional features of the new mixer are also described.

Torque Measuring System

The system is a commercial unit consisting of a magnetic clutch built integrally with a standard AC squirrel cage motor, as shown in Figure 1. Attached to the AC motor is a drum surrounding a clutch rotor, which is connected through a gear reduction unit to the agitator blades in the mixer. In the clutch rotor is an electric coil. Application of a DC voltage to the coil produces a magnetic flux. The attraction between the magnetic poles created in the rotating drum and those in the coil results in a torque causing the clutch rotor to turn. As long as slippage occurs between the drum and the rotor, the torque is related to the current flowing through the coil, and is indicated by an ammeter.

Another feature of the system is variable speed. The speed of rotation of the clutch rotor is adjustable from zero to about 1500 rpm by means of the speed selector, which adjusts the current to the clutch coil. The electronic control unit then automatically maintains the selected speed by adjusting the current to compensate for variations in torque.

Benefits

Torque readings are helpful in the manufacture of greases in two ways: (1) in grading the finished grease, and (2) in following the processing during the various stages.

From the torque reading, one can reliably predict the penetration of the grease. This saves considerable time in adjusting the oil content of the grease so as to obtain the desired penetration.

For a given grease, the torque required to maintain a selected speed of stirring depends upon the amount of grease in the mixer, the temperature and the consistency of the grease. From data collected in the preparation of greases of different types, nomographs can be prepared relating torque to worked penetration at 77°F.

The use of a typical nomograph is illustrated in Figure 2. The speed of the clutch rotor is adjusted to 500 rpm (mixer speed of 45 rpm) for the torque reading. In the lower portion of the chart the torque is normalized for a standard mixer charge of 40,000 grams. In Example 1, the torque reading is 0.10 ampere and the mixer contains 37,500 grams of grease at 202°F.

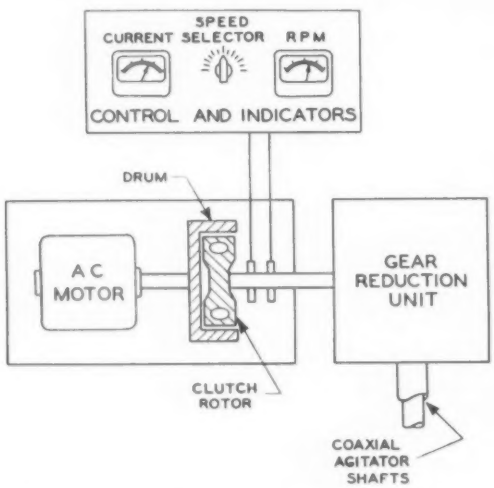


FIGURE 1—Diagram of magnetic clutch.

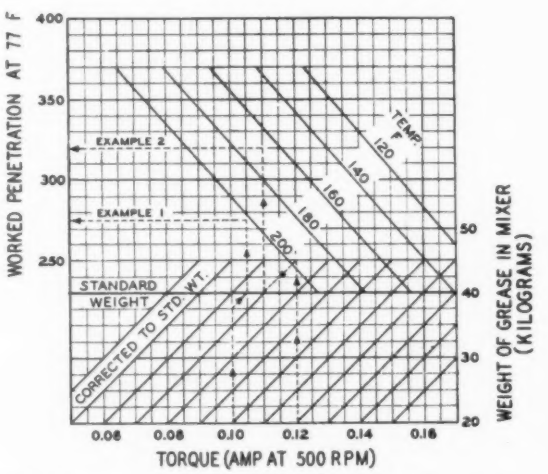


FIGURE 2—Typical chart relating torque to penetration.

According to the nomograph, the worked penetration at 77° is 275. If an NLGI grade No. 1 grease is sought, more oil must be added. After the addition (Example 2), the torque is 0.12 ampere and the contents, 45,000 grams at 167°F. The predicted penetration is now 320, well within the desired penetration range. The time saved in bringing the grease into the desired grade can be as much as an hour. An even greater saving occurs when the batch is divided into two or three grades.

The nomograph in Figure 2 is drawn on the basis of a linear relationship between torque and the weight of the grease in the mixer, and between temperature and penetration. This is approximately true over the weight range of 35,000 to 45,000 grams of grease and the temperature range of 140°F to 180°F. The accuracy of the nomograph diminishes as the weights and temperatures digress from these ranges; however, our experiments are generally designed to produce 40,000 grams of grease, to be drawn from the mixer at about 160°F.

The torque measurement is also helpful in following the manufacture of a batch of grease. Gross changes such as phase changes are, of course, evident from the torque readings. Less obvious changes, such as undue loss of consistency, can be quickly spotted. Reproducibility of successive batches of the same grease is improved because the oil addition and rate of cooling during the mixing-off step can be adjusted to maintain the desired consistency.

The importance of processing conditions on the penetration of the finished grease is illustrated in Figure 3. In Case 1, the dehydrated soap concentrate is partially cooled before oil is added, thereby increasing the torque from 0.08 to 0.12 ampere at 500 rpm. In Case 2, the oil is blended into the soap concentrate in the mixing-off step without auxiliary heating or cooling at the start. In Case 3, the steam pressure is maintained in the jacket while about 5000 grams of oil are added. Normal processing is then followed, except for a little auxiliary cooling near the end to adjust the temperature to 170°F to 180°F.

The effect of the different processing conditions on the penetration of the finished grease is summarized in the following table:

Case	*Torque During Processing*	*Worked Penetration*
1	High	285
2	Medium	310
3	Low	330

The data show the importance of reproducing processing conditions in order to obtain reproducible results. It should be pointed out, however, that high torque during processing does not result in stiffer products with all soap-thickened greases. With some

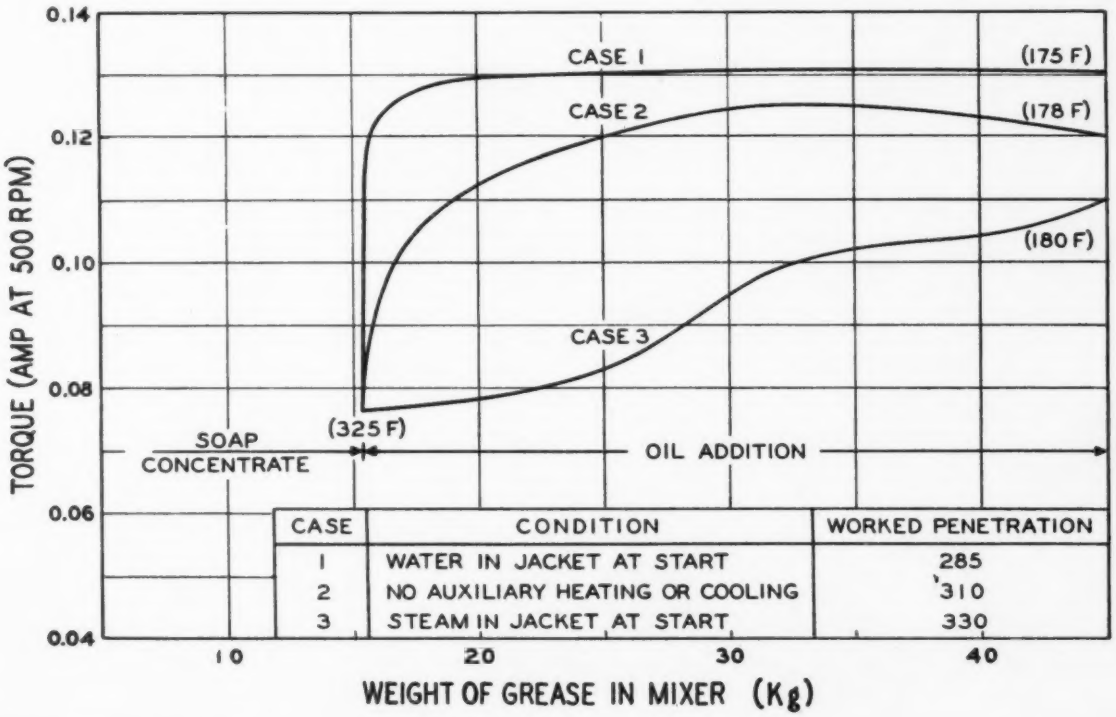


FIGURE 3—Torque resulting from three different processing conditions.

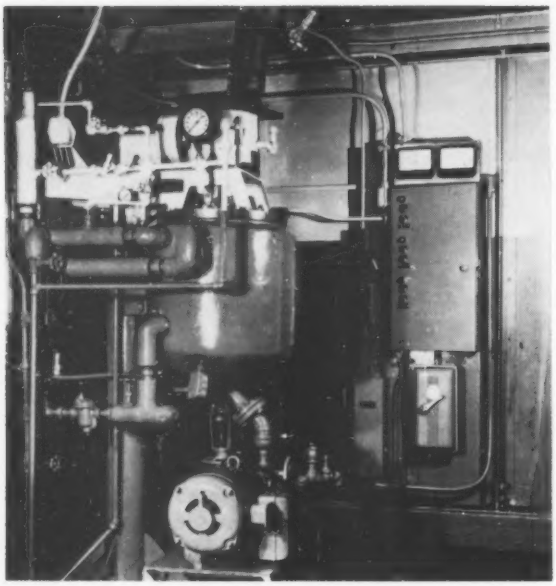


FIGURE 4—A new laboratory grease mixer with magnetic clutch torque device.

soaps, stiffer greases result from Case 3 type of processing. In any event, with torque measuring instrumentation, the optimum processing conditions can be more readily determined and reproduced.

Commercial Application

Torque measuring instrumentation would facilitate the commercial manufacture of lubricating greases. While the expense of revising existing grease mixers may not be justifiable, the incorporation of the instrumentation in new installations should have a quick payout. The benefits would be the same as those obtained in the laboratory. Time spent in grading would be materially reduced and the processing conditions could be followed more closely so that the optimum results should be obtained with each succeeding batch.

Other Features of the Laboratory Mixer

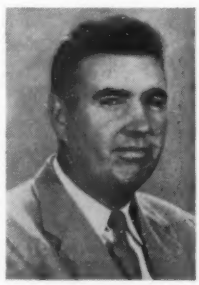
The laboratory mixer was designed for maximum versatility. It was built to equal commercial, double action mixers in performance and also to be useful in the preparation of chemicals which are becoming increasingly important in grease making. It is equipped with a variable speed gear pump for recycling or discharging the contents of the mixer. Design features of the mixer, which is shown in Figure 4, are as follows:

Capacity	—45 kg. (100 lb.)
Construction material	—18-8 stainless steel (AISI type 304)
Heating	—Hot oil, capable of heating 100 pounds of grease 2°F per minute at 300°F.
Cooling	—Partial water jacket, capable of cooling 100 pounds of grease 2°F per minute at 225°F.
Blades	—Counter-rotating, with scrapers.
Temperature	—600°F maximum
Pressure	—150 psi. maximum

The new laboratory mixer has proved to be valuable in our grease research and development. With the magnetic clutch, it has been possible to study processing variables systematically and to reproduce processing conditions during the study of composition variables. A similar device on large mixers would greatly aid the commercial manufacture of greases.

J. L. DREHER *received an AB degree in chemistry from the University of California in* 1935 *and began working for General Petroleum Corp. In* 1943 *he joined the metallurgical laboratories (Manhattan Project), Chicago university. The following year he was employed by Hanford Engineering Works, a subsidiary of E. I. du Pont de Nemours & Co. In* 1945 *Mr. Dreher joined California Research Corp., where he is presently group supervisor of the grease research and development laboratory. He is a member of ACS, ASLE and the American Association for the Advancement of Science. A frequent contributor to the* SPOKESMAN, *he is presently vice-chairman of the subcommittee on the procurement of technical papers for publication.*

About the Authors



C. F. CARTER *obtained his BA degree from Polytechnic College of Engineering in* 1934. *The following year he joined California Research Corp., operating company of Standard Oil Co. of California. For the past* 16 *years, Mr. Carter has been engaged in the development and manufacture of lubricating greases with California Research. An interested member of ASLE, he has been a frequent contributor to the* SPOKESMAN.

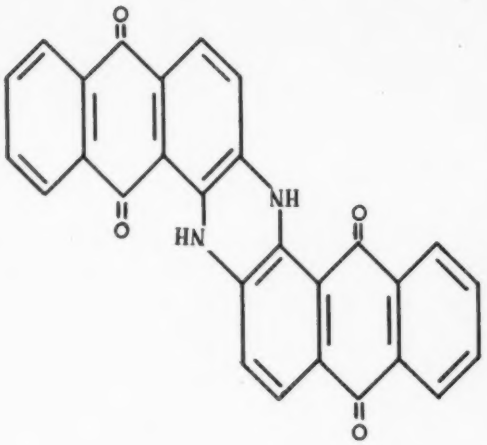


FIGURE 1—Structure of anthraquinoneazine thickener.

FIGURE 2—Electron micrograph of thickener in oil.

Greases for Extreme Environments

By: J. W. Armstrong, J. R. Handschy and D. E. Loeffler
Shell Oil Company

Presented at the Air Force-Navy-Industry Conference on Lubricants, February, 1959.

WITH the rapid change in our ideas of what constitutes high temperature applications for lubricants, we may soon need some new adjectives to describe the requirements of the future. Only a few years ago, 300°F was considered a high temperature for the operation of grease-lubricated antifriction bearings; 450°F would be considered very high temperature; and present work at 600°F could be called extremely high temperature operation. There will be need for a new terminology a few years hence to cover the next range.

However, upper temperature limits are not the only major obstacles. Low temperature requirements are also steadily being extended and, for some applications, speeds and loads are increasing. In addition, the prospect of operation under bombardment by radiation must be considered. Hence the environments in which future lubricants must live are extreme ones, covering a great range of temperature, and possibly of radiation as well.

To develop greases to live in such difficult environments, it was necessary to find a thickening agent of great thermal and radiation stability, insoluble in lubricating fluids, and possessing the highest possible melting point, which immediately eliminated soaps from consideration. Inorganic materials, such as silica, require a waterproofant coating which generally limits their high temperature performance. A study of the most stable organic compounds indicated that large aromatic molecules related to anthraquinone might possess the desired properties. After screening many greases made from such compounds for thermal and oxidative stability, the most promising substance found was an anthraquinoneazine. This material is commercially used as a vat dye, and has the chemical structure shown in Figure 1. It possesses unusual stability to heat, as it does not melt or decompose in air until a temperature of 875°F-900°F is reached. It occurs in a crystalline form such that when it is dispersed in an oil, the long narrow crystals set up the necessary gel structure to make a grease. A good view of these needle-shaped particles in oil is given by the electron micrograph in Figure 2.

In addition to excellent thermal stability this thickening agent, since it consists of large aromatic molecules, has excellent resistance to radiation damage. When incorporated with a radiation-stable fluid, a

TABLE 1
Properties of Dye-Thickened Greases

Base Fluid:	*Silicone*	*Ester*	*Mineral Oil*
Test Method			
Dropping Pt., °F (ASTM D-566)	>550	>500	>500
Water Resistance, % loss (ASTM D-1264-53T)	none	none	none
Oil Separation, 30 hr, % (Fed. Method 321)	3.9 at 450°F	2.1 at 350°F	0.4 at 212°F
Work Stability, change in ASTM pen. after 100,000 strokes	45	30	25

grease can be obtained which undergoes only a little softening after absorbing 10^9 rads of beta radiation, and is still a workable grease, though harder, at twice this dosage.

Other properties of this anthraquinoneazine which recommend it as a grease thickening agent are illustrated in Table 1. Greases made using various fluids such as mineral oil, silicone and an ester are included. The consistently high dropping point reflects the high melting point of the thickener. All three greases showed excellent water resistance. The ability of this anthraquinoneazine thickener to form a stable gel structure is demonstrated in all three fluids both by the low value of oil separation and the small change in consistency after working for 100,000 strokes. In addition to these attributes, we have evidence that the thickening agent itself functions as an oxidation inhibitor, thereby improving the oxidation resistance of greases made with it. This has been demonstrated with a diester fluid as a reduced oxidation rate at 300°F, as shown in Table 2. Another example is given in Figure 3 where the use of this agent brings about a reduced rate of viscosity increase of a silicone fluid at 500°F.

TABLE 2
Dornte Oxidation Test, 300°F

Time (Hours) to Absorb	*Diester*	*Diester + 5% Thickener*
250 ml Oxygen	1.5	3.7
750 ml Oxygen	2.3	4.9
1500 ml Oxygen	4.7	10.0

Larsen, R. G., Thorpe, R. E., and Armfield, F. A., Industrial and Engineering Chemistry, 34, page 183 (1942).

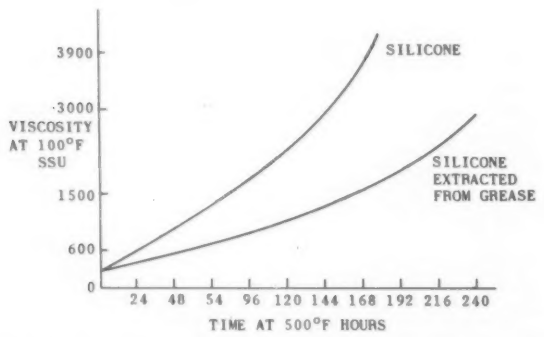


FIGURE 3—Effect of thickener in reducing rate of viscosity rise of silicone.

All of the evidence accumulated so far indicates that an anthraquinoneazine will function as a thickening agent for greases to meet the demands of extreme environments, both thermal and radiation. The limiting factor in every case is the fluid; no fluid has been found to equal the thermal, oxidation and radiation stability of the anthraquinoneazine thickener. Hence, for each application a certain compromise must be made, based on the characteristics of the oil used. When more suitable oils are available, greases thickened with this material should be suitable for use at temperatures approaching 800°F.

For extreme high temperature applications, silicones with a high phenyl to methyl ratio are at present the best choice for base fluid because of their low volatility, good thermal stability and oxidation resistance. However, their limited load carrying ability, particularly for steel on steel, restricts their use to rolling contact ball bearings or service other than steel on steel. The excellent bearing life given by such a silicone grease at elevated temperatures in the ABEC-NLGI Test Rig at 10,000 rpm is shown in Table 3.

TABLE 3
High Temperature Performance

NLGI-ABEC Test Rig, 10,000 rpm *Temp. °F*	CRC L-35 Procedure *Hours to Fail*
450	1,181
500	621
600	162

With the high phenyl/methyl silicone base fluid, the low temperature properties of the grease do not meet the requirements of the MIL-G-25013A specification, which requires an apparent viscosity at −65°F of not over 15,000 poises at 20 reciprocal seconds. By the use of a silicone fluid with a lower phenyl to methyl ratio, this requirement can be met with a moderate reduction in bearing life at 600°F, from 162 to 126 hours.

For applications which require better load carrying characteristics than can be provided by silicones, an ester can be used as the base fluid with a corresponding compromise in high and low temperature performance.

TABLE 4

Grease Properties Dependent on Base Fluid (No. 2 Grade Dye-Thickened Greases)

Base Fluid: *Test Method*	*Silicone* 1	*Silicone* 2	*Ester*
Evaporation, 22 hr, % (Fed. Method 351)	1.3 at 400°F	1.6 at 400°F	2.0 at 350°F
Apparent Vis. at 20 sec^{-1} (ASTM D-1092-58T) Temperature for 15,000 poises, °F	−53	below −85	−58
Bearing Performance, 10,000 rpm (CRC L-35)			
hrs at 350°F	—	—	3284
hrs at 400°F	—	—	462
hrs at 450°F	1181	1905	—
hrs at 600°F	162	126	—
Steel on steel wear, (4-ball) scardiameter, mm (See Military Specification MIL-G-25760)	—	3.2	1.03

This type of grease will meet the MIL-G-25760 load carrying requirement of a maximum scar diameter of 1.10 millimeters in the four ball test, using steel balls at 40 kilogram load, 1,200 rpm and 167°F. With this grease, the high temperature bearing life is much less than with the silicone-based greases, yet as discussed later it considerably exceeds the requirements of the above specification, which is 400 hours at 350°F.

The grease properties which depend largely upon the character of the base fluid, such as bearing performance at elevated temperatures, apparent viscosity, evaporation and scar diameter in the four ball test, are listed in Table 4 for the three greases just discussed. These values demonstrate the limitation placed upon each grease under certain extreme conditions by the nature of the base fluid.

If the grease must operate in the presence of a high radiation flux, or for a long period of time under weak radiation, a different base fluid must be used since both silicones and esters are unstable to more than moderate dosages of radiation. From the standpoint of radiation stability alone, a highly aromatic mineral oil is an obvious choice, being inexpensive and stable in physical properties to a radiation dosage of over 10^9 rads. By using such a base fluid, however, both high temperature performance and low temperature fluidity must be sacrificed. In choosing a mineral oil of sufficiently low volatility to be useful at a bearing temperature of 300° F, a fairly viscous oil must be used which therefore is not applicable at temperatures much below 0°F. Hence the direction of current work is to extend the low temperature limits while maintaining or improving the high temperature properties.

A further weakness of mineral oils is that they are dependent upon oxidation inhibitors to obtain resistance to oxidation at elevated temperatures. In performing their function of stopping reactions which are initiated by the radiation, these inhibitors are largely destroyed, and the oxidation stability of the irradiated grease drops to that of the uninhibited material. A great improvement in oxidation stability at elevated temperatures can be obtained by using different base fluids, particularly suitable being the polyphenyl ethers. The properties of these compounds are fully discussed in the paper "Polyphenyl Ethers As High Temperature, Radiation Resistant Lubricants" prepared by C. L. Mahoney and co-workers of Shell Development Co. This improvement is most strikingly shown in high speed bearing life at elevated temperatures. A comparison of the bearing performance of polyphenyl ether grease with one based on an aromatic mineral oil is given in Table 5, both before and after irradiation. The ether used in this grease was tertiary butylated bis (para phenoxyphenyl) ether. The most notable result

TABLE 5

Bearing Performance at 10,000 RPM of Dye-Thickened Greases

Base Fluid:	*Mineral Oil*		*Polyphenyl Ether*	
Irradiation:	*None*	10^9r	*None*	10^9r
Bearing Life in Hours (CRC L-35)				
at 300°F	436	100	3000	—
400°F	—	—	1931	1082
450°F	—	—	384	149
600°F	—	—	14	—

is the outstanding bearing life of the polyphenyl ether grease after absorbing 10^9 rads in the Van de Graaff accelerator. The bearing performance of the unirradiated polyphenyl ether grease is also extremely promising, for its life at 400°F is equivalent to that of a silicone based grease at 450°F. Further improvements in high temperature properties can be expected from other polyphenyl ethers.

Another comparison between greases based on an aromatic mineral oil and a polyphenyl ether is given in Table 6, showing the change in consistency caused by radiation. The softening which occurs in both greases is comparable and of small magnitude. A comparison of the volatilities of these two greases is also given, as measured by the ASTM Evaporation Test.

This polyphenyl ether thus combines the properties

TABLE 6

Consistency and Volatility Measurements of Dye-Thickened Greases

Base Fluid:	*Mineral Oil*	*Polyphenyl Ether*
% Thickener:	29	25
ASTM Worked Penetration		
Unirradiated	291 (at 77°F)	253 (at 115°F)
After 5×10^8 rads	351 (at 77°F)	292 (at 115°F)
After 10^9 rads	332 (at 77°F)	306 (at 115°F)
Evaporation, 22 hr., % (Federal Method 351)		
At 350°F	0.47	0.34
At 400°F	0.95	1.3

of stability to radiation with excellent oxidation resistance and low volatility at elevated temperatures. The particular polyphenyl ether used to obtain the above results is very viscous at room temperature, so the penetrations were measured at 115°F. Therefore, other members of this family of compounds which are more fluid at room temperature and with even better thermal and oxidation stability, are now under investigation.

For applications requiring only moderate temperatures, several different thickening agents show good stability to radiation. However, where stability to very high temperature as well as to irradiation is necessary, the stability of the dye used in these formulations recommends it as a most versatile thickening agent. Final evaluation of greases for such an environment requires the development of a high speed bearing test which operates under conditions of elevated temperature as well as high radiation flux, and this project is currently in progress.

To round out this discussion of greases for extreme operating conditions, the promising characteristics of an anthraquinoneazine thickening agent in several different base fluids have been borne out by two years field experience. Laboratory and field tests have shown that by using an extremely versatile thickening agent, greases have been prepared to withstand many kinds of extreme environment. For any particular set of such conditions, the base fluid generally proves to be the limiting factor. The choice of fluid must represent a compromise of properties which will satisfy the particular combination of extreme conditions required. Hence the present need is for fluids which are stable to even more demanding conditions of temperature, oxidation, load and radiation. The new polyphenyl ethers give promise of a great improvement in this direction.

J. W. Armstrong *received a BS degree in chemistry from Westminster college, Salt Lake City, Utah in* 1951. *He served two years in the Army Chemical Corps before joining Shell Oil Co. He has been active in both fuel and lubricant research and is interested in high temperature and radiation resistant greases. He is a member of ACS.*

J. R. Handschy *graduated from Olivet Nazarene college, Kankakee, Ill., in* 1951. *He completed two years of graduate study at the University of California. He joined Shell Oil Co. in* 1955 *as a physicist in the radiation chemistry and radiotracers group.*

About the Authors

D. E. Loeffler *graduated from California Institute of Technology with a BS degree in chemistry in* 1940. *He received an MA from the University of California at Los Angeles in* 1941 *and his PhD from Stanford university in* 1949. *Since then, he has been associated with Shell Oil Co. in the development of lubricating oils and greases.*

Background and Current Status of the API GL-4 Designation for Automotive Gear Lubricants

By: C. R. Noll, Gulf Oil Corporation

Presented at the API Division of Refining 25th Midyear Meeting in Detroit, May, 1960

THIS PAPER will review the development and availability of improved automotive rear axle gear lubricants over the past five or six years and endeavor to clarify understanding of the current "API Service GL-4" designation.

"API Service GL-4" was adopted by the Lubrication Committee of the American Petroleum Institute in November, 1957. It was originally included, with supplementary service application explanations, in the SAE Handbook for 1959, and provides the only definition for "Multipurpose" Gear Lubricant now listed in the Handbook. The Committee's purpose in developing this service designation was primarily two-fold:

1. To assist towards making generally available, improved products which, by definition, would assure satisfactory rear axle lubrication of modern high-powered passenger cars and trucks, and
2. To develop a descriptive term which could be used by car manufacturers and oil companies in recommending these improved products to the trade.

This effort was intended and expected to be a fully cooperative venture with the automotive industry, which would result in the ultimate best interest of our mutual customer, the car owner.

Regardless of these well intentioned plans, there has apparently been misunderstanding about the designation by some in both the automotive and petroleum industries.

It is hoped, as a result of this meeting, we can achieve a better appreciation of questions which may exist and develop a cooperative approach for the benefit of all.

A short summary leading up to the present situation might be in order. Five or six years ago, it became increasingly apparent that the quality of automotive gear lubricants, generally available at service stations, would have to be improved, if rear axles then offered were to be satisfactorily lubricated at representative filling stations. Although the volume of rear axle lubricants required to service cars for "makeup" or "refill" purposes is small compared to motor oils, the petroleum industry was concerned about the need for increased performance from the lubricants, as all reputable marketers strive to make products available which will give complete satisfaction in lubricating the various units of their customers' cars which drive in for service.

The horsepower and torque characteristics of engines had increased substantially since the war. At the same time, average and maximum car speeds had increased and rear axle ratios decreased. The continued trend towards lower car heights influenced reductions in the size of rear axle gears, imposing greater unit loads on these parts. The higher performance characteristics demanded of these cars by drivers resulted in greater peak loads being imposed on the real axles in traffic as well as in high speed driving. All of these factors contributed to higher loading of axle gears and created other problems for the lubricant manufacturer.

Many of the then available rear axle lubricants, which often met Government Specification MIL-L-2105, were not considered adequate by engineers in the automotive industry. The natural result of uncertainty in regard to performance was for car manufacturers to recommend against the use of such products in their cars and against the "change" or "makeup" of lubricants at service stations in the field. Concern that unsatisfactory gear lubricants might be furnished, coupled with apprehension about dirt getting into the gear case during field service, apparently was largely responsible for the practice of certain manufacturers to, in effect, seal their rear axles against field reservice by removal of drain plugs from the axle housings. These manufacturers often recommended that only factory specification lubricants be used for "makeup" or "replacement" if it became necessary to add lubricant during the life of the car.

Around the same time, the Ordnance Department became concerned about the ability of many products previously qualified against Specification MIL-L-2105 to perform satisfactorily in the rear axles of military and service vehicles under current operating conditions.

As the need for improved lubricants became increasingly obvious, it seemed reasonable that if a cooperative

effort could be worked out to provide such products, the interests of the car manufacturers, the oil companies and their mutual customer—the car owner, would benefit.

Appreciating these conditions, the Automotive Gear Lubricant Panel of the API Lubrication Committee felt it advisable to develop what interest the car manufacturers might have in a move by the petroleum industry to upgrade the general quality of gear lubricants. Contacts with various representative individuals in the automotive industry, as well as the government, indicated enthusiastic support of a program which would make improved and satisfactory lubricants generally available at service stations. It was also indicated that the military would appreciate assurance of having such improved products widely available throughout the country in case of possible emergency.

New gear lubricant additives were becoming available, which gave promise of providing needed improvement in anti-score and anti-scuff characteristics and at the same time, were satisfactory in other important aspects, such as oxidation resistance, anti-rusting characteristics, etc. CRC committees spent considerable time developing and perfecting test procedures to define acceptable performance characteristics, principally in the way of anti-scoring and anti-scuffing requirements. CRC Procedures L-37 and L-42 resulted from this work.

A performance rating scale or yardstick was proposed by which automotive manufacturers could specify the minimum anti-score, anti-scuff performance level desired for their particular axles. This plan was generally accepted by both the automotive and petroleum industries. In general, the automotive industry indicated that a performance level rating of ten by this scale would be adequate to prevent scoring or scuffing after the "break-in" period and quite acceptable for service station "refill" or "makeup" purposes. Some manufacturers indicated they would prefer products of up to fourteen performance level for servicing "green" gears at the factory. Manufacturers who used lubrited or coated gears reported that levels of six to eight or even lower were quite adequate to assure against scuffing or scoring of gears in service and even for factory fill.

In its effort to cooperate in the program, the oil industry has, over the past several years, made the required lubricants generally available at the service station level. From field reports, they meet the performance characteristics necessary for automotive rear axles in all types of service for which they are recommended, particularly for service station "refill" purposes.

Now, accepting the fact that satisfactory lubricants are here and before continuing discussion of the "API GL-4" service designation, I would like to have you consider a somewhat separate but certainly related matter with which we, in the petroleum industry, are greatly concerned. This proposes that further consideration be given by the automotive industry to recommendations for changing rear axle gear lubricants at reasonable service intervals.

Without going into great detail, we all know that gear lubricants, the same as motor oils, lose their original properties and protective qualities in service and should be changed to restore original effectiveness after normal use. The automotive industry rightfully maintains strict specifications for purchase of "factory fill" lubricants, which are placed in axle housings of new cars to assure proper "break-in" and performance of these units. However, a number of current recommendations infer that such products should be kept in the gear case, without change, for the life of the car. Almost any reasonable study will show that the performance characteristics required in the original lubricant are largely dissipated in as little as five to ten thousand miles of service, and that the lubricants no longer have ability to protect and lubricate as required of the original product by the car manufacturer. Several years ago, we had opportunity to thoroughly analyze over 100 samples of gear lubricants which had been run in Ordnance Department ¾ and 2½ ton trucks for five to ten thousand miles in severe rear axle and transfer case test work. Although the chart has been shown before, I am again showing it to illustrate the amount of deterioration that can and did take place in various high quality gear lubricants after a relatively short period of operation.

From this data you can readily see that what originally went into the axle and gear housings as fresh lubricant certainly lost its original ability to protect and lubricate after what would amount to a season or so of ordinary mileage. I do not believe that any manufacturer would think of accepting used or deteriorated lubricants of this type for placing in new axles when sealed at the factory. Therefore, it is hard to understand why a manufacturer would recommend against changing lubricants at definite intervals in the cars of his manufacture, if, after reasonable use, they might be contaminated and deteriorated to any way near the extent found in these test runs. To assist field service people to do a good job in replacing or servicing rear axle lubricant, it would be helpful if all the rear axle housings were provided with drain plugs.

I think the proposition naturally follows that it would be to the interest of all concerned, if recommendations were made, based on sound technical considerations, to drain gear lubricants because of contamination and deterioration, after they have given reasonable service and to replace them with fresh clean products having adequate protective qualities.

A survey of 1960 service recommendations shows that, on a weighted basis, approximately only 38 per cent of current models are equipped with rear axle lubricant drain plugs and these models recommend

DETERIORATION OF GEAR LUBRICANTS IN SERVICE

LUBRICANT	A	B	C	D	E	F
% INCREASE in Vis. at 210	38	11	41	50	9.5	70
% INCREASE Total Acid No. (ASTM D-974-55T)	38	42	31	110	33	
INCREASE in Insolubles* (% by Wt.) (ASTM D-893-52T)	4.12	2.46	11.8	4.66	1.9	2.0
INCREASE in Resins (% by Wt.) (ASTM D-893-52T)	2.52	2.24	11.76	2.09	1.8	1.4
% DECREASE in Chlorine Content	44	21	30		15	70
% DECREASE in Sulfur Content	40	20	8	20	8	63
% DECREASE in Phosphorous	72	45		83	50	84
Estimated % LOSS Load Carrying Ability (Based on loss of effective chemical constituents)	47	20	30	21	17	70

*Extraneous material generally consisted of iron as major constituent, silicon, aluminum and copper. Water was also present in many samples.

change of gear lubricant at from ten to twenty thousand mile intervals. A similar survey of 1958 models showed that approximately 48 per cent of the cars were equipped with drain plugs and lubricant changes were recommended at specific mileage intervals.

This retrogression in recommended service intervals is not encouraging to the oil industry in its efforts to provide better service and better products to our mutual customers, at filling stations. As a matter of fact, the new improved gear lubricants cost from eight to ten cents per gallon more to manufacture than the lubricants previously available. If this tendency to discourage rear axle service at representative filling stations is continued in the future, there seems little logic in the oil industry's continuing to provide these higher cost lubricants when the savings that could be made by a general reversion to lower cost and lower performance products are considered. After all, a complete rear axle gear lubricant replacement job costs the average car owner only approximately $2.00 on current models--relatively low cost insurance against possible failure for unsatisfactory operation of expensive equipment. Any continuing trend to eliminate rear axle gear lubricant service at filling stations also tends to discourage the oil industry in its efforts to make even better gear lubricants available through research in the future.

However, an attitude of this kind would not be very cooperative and I believe you can expect the oil industry to continue to develop even better products in all lines in the future as it has in the past. Possibly the advent of transaxles will automatically cover the need for gear lubricant change recommendations at reasonable mileage intervals because of the service required of such products.

Again returning to discussion of the current definition and designation for "Multipurpose Type Gear Lubricants (API Service GL-4)." Obviously, a new term or designation had to be developed to describe lubricants which could be used by the automotive and petroleum industries in instruction books and general service information, to recommend these improved products to the car owner. The current definition is as follows:

> "This term designates lubricants which have properties required to provide satisfactory lubrication of hypoid gears and conventional differentials, including adequate load carrying ability for protection of such gears in sustained high speed and/or high torque service in modern high powered passenger cars and trucks. They are suitable for use in spiral-bevel gears, many transmissions, and for worm gears in some types of service. Such lubricants are identified as meeting 'API Service GL-4'."

The definition was developed after considerable study by the Lubrication Committee of the API in conjunction with various representatives of the automotive industry. The definition encompasses a service designation and is *not* a specification. The API Lubrication Committee is not empowered to write specifications and furthermore, we do not believe a minimum performance specification would serve the best interests of those concerned in a situation of this kind. However, in one respect, the definition is really even more specific than the definitions for API Engine Service Classifications for Motor Oil, in that the GL-4 definition does state the term "designates lubricants which have properties, etc." It would seem impossible, from a practical standpoint, to prepare a service definition for rear axles, per se, (similar to the engine service classifi-

cations) which would outline the conditions of load, temperature, design, etc. under which different types of gears operate, and for which a given lubricant should be used. The present "API GL-4" definition leaves it entirely up to the integrity and responsibility of the oil company to decide if the products which it will designate as meeting "API Service GL-4," in fact, correspond to said definition. No policing agency is provided to assure any specific level of quality in this field nor other similar fields, and the integrity of the oil company must be relied upon that its products will provide the service covered by the definition when so marked. Similarly, it is up to the lubricant manufacturer to decide what characteristics in the way of performance levels, oxidation resistance, anti-rust characteristics, etc. must be incorporated in his product to provide this service, and upon which the ultimate reputation and performance of his product will stand or fall.

There has been misunderstanding in some circles that "API Service GL-4" automatically includes conformance with the current Military Specification MIL-L-002105A (Ord) and Specification MIL-L-2105B, soon to be issued. The latter are definite *specifications* and the API designation is a service *definition*. Therefore, there is no requirement that one be a part of the other, although many of the new products marketed under the designation "API Service GL-4" do meet the government specification.

The "API GL-4" definition has been questioned in certain quarters on the ground that no physical, chemical or performance tests are included. As it is not a specification, such tests are not required. There are those who feel that a more specific idea of product performance should be available to understand what can be expected from lubricants so marked. They desire some type of reference to or consideration of established performance procedures for anti-scuffing, anti-scoring, oxidation characteristics, foaming, anti-rust properties, storage stability and possibly other requirements.

Most of us are aware that this over-all subject was rather fully reviewed at the January 12, 1960 meeting of Subcommittee "A"—"Transmission and Axle Lubricants" of the SAE Fuels and Lubricants Technical Committee in Detroit. That discussion questioned the suitability of the material on gear lubricants as now published in the SAE Handbook and considered the possibility of further clarification. It was stated that some organizations had outlined the possible need for even another classification not now covered by current API designations.

At that meeting, it was agreed if appropriate material could be obtained prior to the proposed publication date of the 1962 Handbook, it might be worthwhile to print such supplementary information and make it available to those interested as soon as possible.

At the Subcommittee "A" meeting, representatives of the API Lubrication Committee's Automotive Gear Lubricant Panel expressed a desire to cooperate in any reasonable way to satisfactorily resolve the current problems—as soon as the needs of the automotive industry were sufficiently clarified. It appears desirable that this information, as well as possibly similar information on transaxle requirements, be made available at an early date in order to provide the API with necessary information for action on their part.

Subsequent discussion at the meeting indicated that although there had been quite a few questions raised regarding the quality, performance and purpose of "API Service GL-4" lubricants in the past, actually on getting down to cases there seemed to be very little verified trouble reported from the use of these lubricants, as marketed by reputable suppliers.

At the earlier January, 1959 meeting of the CRC Gear Lubricants Group, performance of the new type lubricants was reviewed and some isolated criticism was voiced by several members regarding possible corrosion difficulties reported from the use of some of the new higher level lubricants marked "API-GL-4." These reports were concerned primarily with low temperature corrosion and copper corrosion. However, after further discussion and investigation, it was decided that the number of complaints were not considered of sufficient importance to justify further cooperative activity by that committee at the time. Since the few isolated complaint cases did comprise only a very small fraction of the equipment for which "API Service GL-4" lubricants are used and recommended, the conclusion was that the reports should not be viewed with too much alarm until and unless more specific and confirmatory data and reports were received. In so far as I know, nothing further has subsequently been officially confirmed in this respect.

In the original development stages two or three cases of serious trouble were reported. However, subsequent changes were promptly made in the quality of such products and we have heard of no serious complaints over the recent past which would truly be attributed to the quality of the new lubricants. I think we can now safely conclude that lubricants marked for "API Service GL-4" and available from reputable suppliers are quite satisfactory and will cause no trouble in the service for which they are recommended.

This then brings us down to the current situation and the suggestion of a program which could be worked out and which, as a matter of fact, is already under way. To review:

1. The "API GL-4" definition covers a service *designation* and is *not a specification*. In this respect, it is similar to the API Service Classifications for automotive engines. No physical, chemical, or performance specifications are involved or intended in the Service designation.

2. Responsibility for deciding upon quality of prod-

uct marketed as meeting "API Service GL-4" rests entirely with the respective lubricant manufacturer. The quality and reputation of each product stands or falls on the service furnished by that product. Here again, the situation is like the API Engine Service Classification System, where it is the responsibility of each oil company to determine the quality of the oils it markets, for example, "For Service MS."

3. As a result of cooperative effort, Section G-IV of Technical Committee B, ASTM has proposed, for purposes of information, performance test procedures designed to indicate the engine requirements as a basis for development of motor oils marked for "API 'MS' " service. As the gear lubricant situation is quite analogous, it would seem in line for Section G-IV to propose performance test procedures, for the information and consideration of the oil industry in formulating rear axle lubricants to be marketed for "API Service GL-4."

4. Various automotive manufacturers may have different ideas covering these requirements. This point is mentioned as background for a plea that if more specific characteristics are indicated for consideration, Section G-IV should decide on one generally satisfactory set of procedures rather than to call on the petroleum industry to provide several different levels of quality to satisfy individual car manufacturers. It is not economically feasible for lubricant suppliers to make several products of different performance levels available in a line of gear lubricants and the probability of confusion arising in field service argues against having more than one quality level. It is further suggested that if performance characteristics are to be indicated, they also include requirements to cover satisfactory performance in limited slip differentials, which are widely used.

As previously discussed, a program of this kind is already underway and constituted a part of the recommendations of Subcommittee "A" to the SAE Fuels and Lubricants Technical Committee at its recent meeting in Detroit in January. At that time, it was mentioned that initial suggestions might be expected from Committee G-IV within a reasonable period. If and when these recommendations are completed, information regarding them could be made available in both industries through the media of the secretary of ASTM Committee D2, in the same manner in which information on motor oil test procedures is now being handled.

I would like to summarize and conclude as follows:

1. Improved rear axle gear lubricants are now generally available at retail service stations throughout the country, marked "For API Service GL-4," which can be depended upon and which have proven entirely satisfactory for practically all automotive rear axle lubricant requirements.

2. The effort to develop and make these improved lubricants available was originally conceived by the petroleum industry as a cooperative venture.

3. Apparently due to a desire for further assurance of product performance, "API GL-4" has not been adopted and used by the automotive industry as widely as originally anticipated by the petroleum industry.

4. There is ample evidence that gear lubricants do deteriorate appreciably in service and should be renewed at reasonable intervals to provide best performance and low maintenance costs in the equipment of our mutual customer—the car owner.

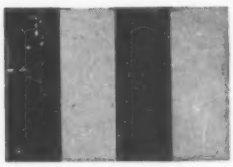
5. Further information in respect to desired performance of lubricants marked for "API Service GL-4" could be proposed by Committee G-IV of ASTM.

6. The API Lubrication Committee will be happy to consider and cooperate in the revision of current API Gear Lubricant Type Designations or in the development of new designations when it has been indicated to the satisfaction of both industries that such revisions should be made or that new designations should be established.

Although much has been said both pro and con over the past several years in regard to this problem, the path to better understanding and close cooperation seems perfectly clear. I trust it can be accomplished through the usual meetings and conferences within the relatively near future. After all, both industries are interested in providing assurance to the car owner that the products which are recommended to him through instruction books and service bulletins and subsequently furnished by the oil industry can be expected to provide most economical operation and long life for the equipment in which he has invested his money. ■

About the Author

C. R. Noll *has been associated with Gulf Oil Corp. since* 1924, *following his graduation from the University of Pittsburgh with the degree of petroleum engineer. After several years of service as a lubrication engineer in the automotive division of the lubricating sales department, he was made manager, lubricating sales, automotive division. Since that time he has served as director, automotive products engineering, and coordinator, product application. Mr. Noll has served as chairman of the API Lubrication Committee's automotive gear lubricants panel, as well as on other subcommittees. He is a past chairman of the Pittsburgh section of the Society of Automotive Engineers. Mr. Noll has been a contributor to the* Spokesman *previously.*



Literature and Patent Abstracts

Composition

Silica-Thickened Lubricating Greases Containing Carbamate Ester

Claims are made by Remes, Martinek and Fronczak (U. S. Patent 2,921,900, assigned to the Pure Oil Co.) that certain esters of carbamic acid and substituted carbamic acids are superior dispersants for silica thickeners in lubricating fluids. While some of these esters also prevent separation of silica when the product is in contact with water, the addition of polyalkylene glycols (Ucon fluids) is also desirable.

For example, a lubricating grease was prepared as follows. A grease kettle was charged with 91.2 parts of 160 viscosity bright stock and 0.8 parts of 2-hydroxethyl-N-methyl carbamate. After mixing and heating to 190 to 250°F, 8.0 parts of Cab-O-Sil was added and heating was continued for 90 minutes at 190 to 205°F. When this mixture was passed through a colloid mill set at 0.003 inch clearance, a product resulted which had an unworked penetration of 261 and a worked penetration of 263.

However, upon contact with water the lubricating grease decomposed. If, when compounding, an amount of Ucon LB 550X equal to that of the carbamate ester was included, the final lubricant was stable to the action of water. That some of the carbamate esters tend to give water repellent qualities is shown by one composition in which n-butyl carbamate was used. In this case the silica did not settle out upon contact with water.

Metal Salts of Phosphoric Acid Esters As Grease Thickeners

In British Patent 829,166, issued to Esso Research and Engineering Co. and invented by Bonmartini and Pattenden, claims are made for thickeners for lubricating greases consisting of metal salts of esters of

Number Five in a Series . . .

OVER 30 YEARS OF PROGRESS

SERVICE FOR:

- Steel Mills
- Paper Mills
- Sugar Mills
- Rice Mills
- Saw Mills
- Flour Mills
- Cement and Phosphate Mills
- Coal Mining Machinery
- Earth Moving Machinery
- Underground Machinery
- Underwater Machinery
- Marine Equipment
- Steam Engines
- Farm Machinery
- "Tailor-Made" products for special applications on specialized equipment.

If we can help you, write, wire or call . . .

JESCO LUBRICANTS CO.

P.O. Box 7331 North Kansas City, Missouri GRand 1-4590

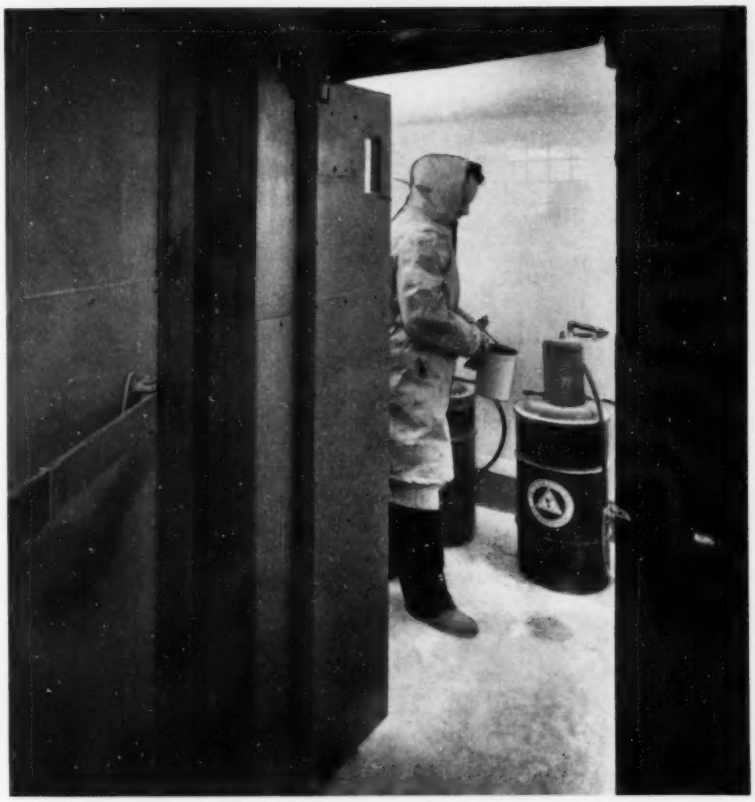
phosphoric acid. Either alkali or alkaline earth metal salts can be used, but the former have greater bodying effect. Certain surface active agents may be included in the composition as an aid to dispersion. Either natural or synthetic lubricating oils can be used in these greases.

A typical lubricating grease was made by first mixing and heating to 250°F, 18 parts of the n-propyl ester of orthophosphoric acid consisting of 3 parts of the mono-n-propyl dihydrogen phosphate and 7 parts of the di-n-propyl monohydrogen phosphate, and 75.6 parts of mineral oil having a viscosity of 300 SUS at 100°F and a 70 V.I. After the temperature of the mixture was allowed to drop to 225°F, 6.4 parts of lithium hydroxide as a water solution were added and the resulting mixture was heated to 300°F for one hour. Upon cooling to room temperature a lubricant resulted which had a worked penetration of 340 and which decomposed at 425°F when subjected to a dropping point test.

In a similar manner a lubricating grease was made from 18 per cent iso-propyl acid phosphate, 6.4 per cent lithium hydroxide, 1.8 per cent Victamine C, and 73.8 per cent of the 300 oil. This had a worked penetration of 159. When the Victamine C was omitted a product having a worked penetration of 180 was formed which broke to 210 after 10,000 strokes in a grease-worker but which showed no leakage in an ASTM Wheel Bearing Test.

Stabilizing Oil Dispersions of Calcium Acetate

Calcium acetate can be stably dispersed in lubricating oil to form either lubricating greases or fluid lubricants. To maintain such a dispersion Morway (U.S. Patent 2,929,783, assigned to Esso Research and Engineering Co.) includes a surface active agent in a proportion of 0.05 to 1 part based on the weight of the calcium acetate. Desirable surface active agents are non-ionic



Grease Marketers . . . How Do Your Greases Perform at -40°F?

Quality and dependable performance are prime requisites of grease marketers who value the integrity of their brand names.

Laboratory-testing, as in this specially-built Cold Room, where temperatures can be brought to –40°F., insures dependable testing of International-made greases for those applications where low temperature conditions of operation are encountered.

This type of continuous research is what you have a right to expect from your supplier.

We invite your inquiry.

INTERNATIONAL LUBRICANT CORPORATION

New Orleans, Louisiana

Manufacturers of Top Quality Lubricants
AVIATION • INDUSTRIAL • AUTOMOTIVE
MARINE

With Research Comes Quality, With Quality Comes Leadership

or cationic products containing polyalkyleneoxy groups and are illustrated by Pluronics L-44, L-62 and F-68 or Ethomeen T/25.

A typical lubricating grease was made by mixing 17 parts by weight of hydrated lime, 2 parts by weight of Pluronics L-62 (copolymer of ethylene and propylene glycol having a mol weight of about 2300 and a molar ratio of ethylene oxide groups to propylene oxide groups of about 1.15), and 55 parts of a mineral oil having a viscosity of 80 SUS at 210°F. After a uniform slurry of the above was obtained, 25 parts by weight of glacial acetic acid were added slowly, causing a rise in temperature to about 220°F. After further stirring for 15 minutes, the mass was heated to 320°F to dehydrate. The heating was then discontinued and the product allowed to cool to 200°F while stirring. One part by weight of phenyl alpha naphthylamine was then added after which the grease was passed through a Gaulin homogenizer operating at 6000 psi shear.

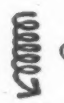
A smooth lubricating grease resulted which had a worked penetration of 265 and a dropping point above 500°F. Twenty weight per cent of this grease was blended with 80 weight per cent additional oil and again homogenized to give a smooth fluid having viscosities of 1400 SUS at 100°F and 102 at 210°F. A sample bottle filled with this fluid lubricant was held in an oven maintained at 210°F and after 48 hours showed no salt precipitation.

Calcium-Lithium Base Hydroxy Stearate Lubricating Greases

Sproule and Pattenden in U.S. Patent 2,929,782, assigned to Esso Research and Engineering Co., describe the preparation of a lubricating grease by co-saponifying 12-hydroxy stearic acid with a mixture of about 20 per cent lithium hydroxide and 80 per cent hydrated lime. This soap formation is carried out at temperatures of 275 to 315°F. This combination of soap thickeners improves the water sensitivity over that of a straight calcium 12-hydroxy stearate product.

A typical lubricating grease was made by mixing 216 pounds of 12-hydroxy stearic acid and 540 pounds of an oil having a viscosity of 60 SUS at 210°F and a 50 VI. This mixture was heated to 180°F before the addition of a slurry of 25¼ pounds of hydrated lime in 90 pounds of water. Five minutes later a water solution of 7¼ pounds of lithium hydroxide was added and the mixture was heated to 300°F, continuing this temperature for about five hours. Since the mass was practically dehydrated at this point, heating was discontinued and 1181 pounds additional oil was added slowly while the grease cooled to 200°F. A solution of 10 pounds of phenyl alpha naphthylamine in 10 pounds of oil was added before packaging the lubricant at 190°F without milling.

This gave a lubricating grease, containing 12 per cent mixed soap, which had a worked penetration

If it rolls on an axle or turns in a bearing or rides on a shaft if it slides in a groove or moves on a pivot if it bores  or cuts or transmits pressure
one of Sinclair's 500 specialized lubricants is designed to make it work <u>better.</u> For answers to your lubrication problems, write today to

SINCLAIR REFINING COMPANY

Technical Service Division, 600 Fifth Ave, N.Y. 20 N.Y.

of 275, a dropping point of 318°F and a water absorption of 150°F of 11 cc.

Lithium-Calcium Base Lubricating Greases

Lithium-calcium base lubricating greases having a high resistance to boiling water can be prepared from unsaturated saponifiable material by confining the unsaturated fatty acid radicals to the calcium soap portion of the thickener. Such products are described by O'Halloran in U.S. Patent 2,929,780 which is assigned to Esso Research and Engineering Co.

In general, conventional methods are used to form greases of the individual bases and then the two products are blended at temperatures of 180 to 225°F. Thus, lots of lubricating greases were made from lithium oleate alone, lithium stearate alone, calcium oleate and calcium stearate all in a mineral oil of 55 SUS at 210°F.

By blending these lubricants so that the final mixture had either 2.8 per cent lithium oleate, 5.2 per cent lithium stearate, 4.0 per cent calcium stearate and 88 per cent oil; or 8.0 per cent lithium stearate and 4.0 per cent calcium oleate in 88 per cent oil; products were obtained which gave clear boiling water when 2 grams of the grease were added to the beakers.

The iodine number of the fatty acids forming the lithium soap should be less than 40 and those in the calcium soap may have iodine numbers of 75 to 150. The finished products are fibrous but no other characteristics are given.

Oxime Derivatives in Complex Thickeners for Lubricating Greases

According to Morway and Bartlett (U.S. Patent 2,929,784, assigned to Esso Research and Engineering Co.) metal salts of oximes can be included in complexes formed by acetates and intermediate or high molecular weight fatty acids. Aldoximes, which are preferred, are prepared by reacting aldehydes with hydroxylamine.

AREN'T YOU GLAD YOU USE

HARCHEM CENWAXES?

Not everybody uses Harchem Cenwaxes, but if *you* do, you've got the drop on competitors who *don't.*

Cenwaxes are highly compatible with high napthenic content oils. They impart greater shear and temperature range stability to any multi-purpose metallic soap greases. Greater water resistance, too.

If you are not using Harchem Cenwaxes but are looking to improve your lubricants—look into Cenwax A (12 Hydroxystearic Acid) or Cenwax G (Hydrogenated Castor Oil Glyceride).

WRITE FOR BULLETIN OR CONSULT CHEMICAL MATERIALS CATALOG PAGES 173-175

HARCHEM CENTURY BRAND

HARCHEM DIVISION

WALLACE & TIERNAN, INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
PLANT IN DOVER, OHIO
IN CANADA: W. C. HARDESTY CO. OF CANADA, LTD., TORONTO

Thus, a lubricating grease was made by charging 9.1 per cent of hydrated lime and 72.4 per cent oil of 55 SUS at 210°F to a fire heated kettle and mixing intimately. Next 4 per cent of hydrogenated fish oil fatty acids was added followed by 12 per cent of glacial acetic acid and finally by 2 per cent C_8Oxo aldoxime. The resulting mixture was then heated to about 450°F where heating was discontinued. After the grease mixture had cooled to about 250°F, 0.5 per cent phenyl alpha naphthylamine was added and upon further cooling to about 150°F the mass was homogenized.

The resulting lubricating grease had a worked penetration of 250 and a dropping point above 500°F. In a Norma Hoffman Oxidation test over 400 hours gave a drop of five pound pressure. With a load of 40 pounds a Timken Test was passed and in a 4 Ball Wear Test the scar diameter was 0.24 mm. When tested in a bearing operating at 250°F and 10,000 rpm, the lubricating life was over 1500 hours.

Lubricating Greases Containing Salts Of Carboxylic Copolymers

Morway, Bartlett, Gleason and Lippincott in U.S. Patent 2,929,785, assigned to Esso Research and Engineering Co., describe lubricating greases in which the thickener consists of 2 to 35 per cent of an alkali metal salt of an acidic polymeric material, 2 to 6 per cent of an alkali metal salt of a low molecular weight acid, such as acetic, and 2 to 30 per cent of an alkali metal soap of high molecular weight fatty acids.

A desirable polymer can be formed from about equal molar proportions of acids such as acrylic or methacrylic, and unsaturated compounds such as olefins, conjugated diolefins, vinyl esters or isopropenyl esters. For example, 380 grams of butadiene and 20 grams of freshly distilled glacial acrylic acid were added to 900 ml. of heptane containing 25 ml. of cumene hydroperoxide of 50 per cent purity and 1.5 grams of diisopropyl xanthogen disulfide. The mixture was heated in a stainless steel bomb for 24 hours at 110°C, after which the unconverted butadiene was removed from the liquid by distillation, leaving a copolymer having a molecular weight of 4,000 to 5,000 containing 7 per cent of combined acrylic acid.

To form a lubricating grease, 10 per cent of the above copolymer, 10 per cent of Hydrofol acid 54 and 23 per cent of a lubricating oil, having a viscosity of 55 SUS at 210°F and a V.I. of 55, were mixed and warmed to 150°F before add-

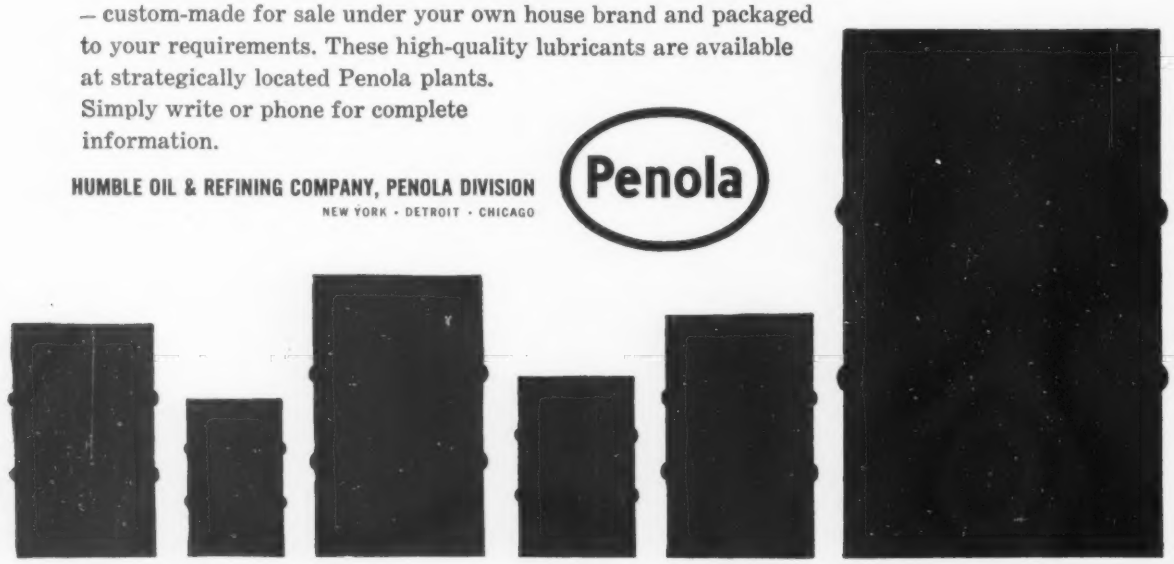
PENOLA INDUSTRIAL & AUTOMOTIVE LUBRICANTS

Custom-made, custom-packaged for you!

Penola is a dependable source for industrial and automotive lubricants – custom-made for sale under your own house brand and packaged to your requirements. These high-quality lubricants are available at strategically located Penola plants. Simply write or phone for complete information.

HUMBLE OIL & REFINING COMPANY, PENOLA DIVISION
NEW YORK · DETROIT · CHICAGO

Penola



FRESH FROM OUR RESEARCH LABORATORIES

A NEW CONCEPT IN LUBRICATION

5330 SPECIAL E.P. LUBRICANT

ALL THIS

NO MELTING POINT

SHEAR STABLE

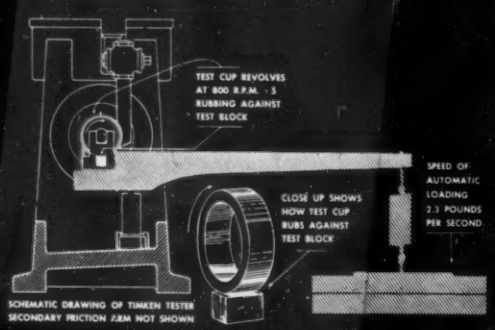
HIGH OXIDATION RESISTANCE

THE ULTIMATE IN LUBRICANT

- ✲ FLEXIBILITY
- ✲ DEPENDABILITY..
- ✲ PUMPABILITY
- ✲ LONG-RANGE ECONOMY...

AND A **45 LB. MINIMUM TIMKEN OK LOAD RATING** TOO!

THE TIMKEN LUBRICANT TESTER


TEST CUP REVOLVES AT 800 R.P.M. - 5 RUBBING AGAINST TEST BLOCK
CLOSE UP SHOWS HOW TEST CUP RUBS AGAINST TEST BLOCK
SPEED OF AUTOMATIC LOADING 2.3 POUNDS PER SECOND
SCHEMATIC DRAWING OF TIMKEN TESTER SECONDARY FRICTION ARM NOT SHOWN

NOW AVAILABLE TO ALL PROGRESSIVE GREASE MARKETERS UNDER THEIR BRAND

WRITE • WIRE OR CALL FOR SAMPLES • PRICES AND FULL INFORMATION

SPECIALIZING IN THE CUSTOM MANUFACTURE OF PETROLEUM LUBRICATING GREASES AND SPECIALTIES

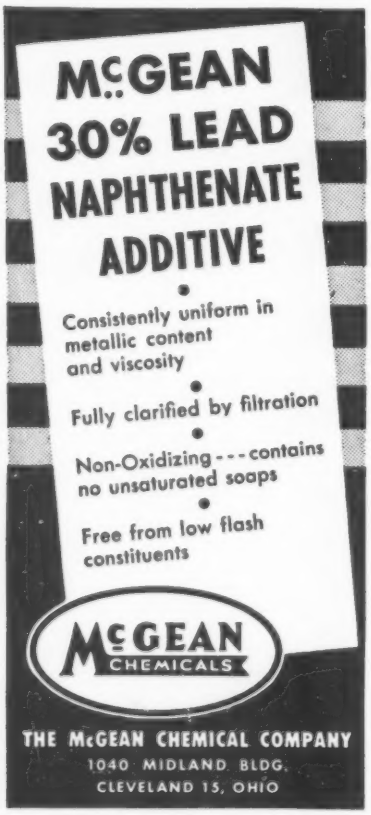
SOUTHWEST GREASE & OIL CO., INC.

220-230 WEST WATERMAN • WICHITA 2, KANSAS

SOUTHWEST Good GREASE

ing 4 per cent glacial acetic acid followed immediately by 6.5 per cent sodium hydroxide as a 40 per cent aqueous solution. After heating to 300°F, 45.5 per cent additional oil was added and the mass heated to about 485°F. Heating was then discontinued and the composition was cooled to 275°F, where 1 per cent of phenyl alpha naphthylamine was added. Upon further cooling to 200°F, the product was passed through a Gaulin homogenizer to give a smooth, slightly rubbery lubricating grease having a worked penetration of 180 and a dropping point of 500°F. There was no loss of lubricant in a water wash out test and in a bomb oxidation test a five pound drop in pressure occurred in 350 hours.

In other formulations, a reduction of the soap content together with the use of a less polar lubricating oil resulted in products of a less rubbery nature.



Process

Process for Making a Lithium-Calcium Base Lubricating Grease

Beerbower, O'Halloran and Vesterdal in U.S. Patent 2,929,781, assigned to Esso Research and Engineering Co., describe a semi-continuous method for the manufacture of lithium-calcium base lubricating greases containing two to eight molar proportions of lithium soap to one molar proportion of calcium soap.

The suggested procedure is illustrated in the case of a product made from the following weight per cents: animal fatty acids (197 saponification number and 40 iodine number) 12; lithium hydroxide monohydrate 1.46; hydrated lime 0.67; and mineral oil, of 70 SUS at 210°F, 85.87. The alkalies and about 10 per cent of the oil were slurried in a rapid soap cooker. Next, the fatty acids were added followed by enough more oil so that the soap concentrate formed would contain about 55 per cent soap. The resulting mixture was then heated to about 345°F at a pressure of 120 psi for 10 minutes while being circulated. The pressure in the cooker was then reduced and vacuum applied to substantially dehydrate the soap-oil concentrate. This mixture at 345°F was then passed to a Lancaster mixer where it was diluted with oil at 80°F to form a lubricating grease containing about 13.5 per cent soap. This product was passed to a grease kettle where further oil reduced the soap content to 12.1 per cent and cooled the mass to 117°F.

A sample of this grease was milled in a Charlotte mill to give a product having a worked penetration of 310 which had a leakage of 3.4 grams on a Wheel Bearing Test. Through a Morehouse mill the penetration was 324 and leakage in the Wheel Bearing Test 3.7 grams.

In another procedure, after the pressure on the cooker was reduced the wet concentrate was passed to the Lancaster disperser and consequently the blended product containing 12 per cent of soap also had 1.75 per cent water. This wet grease at a temperature of 256°F was passed through a Cornell homogenizer where the moisture content was reduced to 0.2 per cent. After cooling to 135°F and passing through a Charlotte mill, a product having a worked penetration of 283 was obtained.

Bulletin Discusses Effect of FDA Amendment

The effect of the Food Additive Amendment to the Food, Drug and Cosmetic Act on the uses of white mineral oils and petrolatums is discussed in a bulletin available from Sonneborn Chemical and Refining corporation of New York.

The bulletin discusses food grade specifications for white oils and petrolatum, ultraviolet absorbance of white oils, ultraviolet absorptivity of petrolatums, food uses and their tolerances, and a number of applications in the food and related industries where less highly refined mineral oils and petrolatums have been used in the past.

Anyone interested in obtaining a copy of the bulletin, Current Topics No. 144, should send a postcard to the Department of Industrial Research, Sonneborn Chemical and Refining Corp., 300 Park Ave. S., New York 10, N. Y.

Two NLGI Booklets . . .

"RECOMMENDED PRACTICES"

for Lubricating Automotive Front Wheel Bearings

—and—

for Lubricating Passenger Car Ball Joint Front Suspensions

FAMED throughout the world, both of these proved and valuable aids give the recommended practices for application of lubricants . . . for automotive front wheel bearings in NLGI's newest twelve-page booklet . . . and for passenger car ball joint front suspensions, a revised edition of the sixteen-page manual now in its sixth printing. Compiled by experts in the industry, these handy guides are clearly illustrated, with easy-to-read directions. They may be purchased with quantity discounts, and company advertising or public relations messages can be added at cost. Immediate attention will be given to all orders.

PRICE LIST

(Prices apply to both publications)

(1) *Number of Copies*	(2) *Plain, No Imprint*	(3) *Company Name Imprinted, Black*	(4) *Company Name Imprinted, Red*
1 - 4	25c each	. . . . .	. . . . .
5 - 24	20c each	. . . . .	. . . . .
25 - 49	19c each	. . . . .	. . . . .
50 - 99	18c each	. . . . .	. . . . .
100 - 499	$17.00, hundred	$17.00, hundred	$19.00, hundred
500 - 999	$16.00, hundred	$16.00, hundred	$18.00, hundred
1,000 - 10,000	$150.00, thousand	$150.00, thousand	$170.00, thousand
10,000 -	$140.00, thousand	$140.00, thousand	$160.00, thousand

To the prices in column (3) please add a flat charge of $20.00 and to the charges in column (4) a flat charge of $27.00 . . . for type changes. All shipping charges posted on NLGI invoice . . . shipments made by parcel post unless you specify type of shipment desired.

RECOMMENDED PRACTICES FOR LUBRICATING AUTOMOTIVE FRONT WHEEL BEARINGS

☐ Please send _____ of the above to:

COMPANY _____

STREET _____

CITY _____

STATE _____

RECOMMENDED PRACTICES FOR LUBRICATING PASSENGER CAR BALL JOINT FRONT SUSPENSIONS

☐ Please send _____ of the above to:

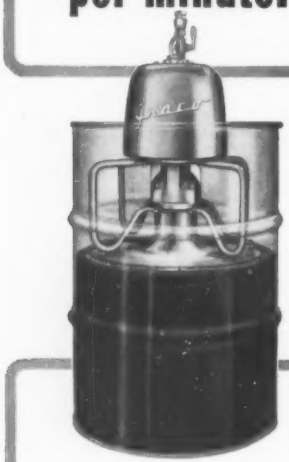
COMPANY _____

STREET _____

CITY _____

STATE _____

Transfer grease 200 Pounds per minute!



●Designed for transfer, batching and packaging operations where grease is removed from drums, the Graco Bulldog Transfer Pump delivers up to 200 lbs. per minute of heavy grease and other semi-solid materials . . . *empties a 55-gal. drum in less than 3 minutes!*

High volume pump starts at TOP of drum, "sucks" way to bottom, cleans drum as it moves. Handles heavy greases in a fraction of the time needed by ordinary pumps. When drum is empty (right), pump can be quickly removed. *Ask for a demonstration!*

Free Idea Book shows Graco Pumps for every need. Send for it today!

GRACO

GRAY COMPANY, INC.

928 Graco Square • Minneapolis 13, Minnesota

(For Graco Suppliers, see SPRAYING or LUBRICATING DEVICES in Phone Book Yellow Pages)

Industry News

Southwest Completes Plant Expansion

APPROXIMATELY two and one-quarter million pounds of finished lubricating oils and greases can be stored in the newly-expanded Southwest Grease & Oil plant.

H. A. Mayor, president of Southwest Grease & Oil Co., Inc., has announced the final completion of the company's quarter-million-dollar expansion program at the Wichita plant.

He also pointed out some of the effects the new building expansion will have on the day-to-day operation of the company. The company now has an oil storage capacity in excess of three-quarters of a million gallons. The continuing expansion within the plant operations now enables the company to store approximately two and one-quarter million pounds of finished lubricating oils and greases. The company has just installed its 31st cooking and blending kettle which, in total production capacity, enables the company to manufacture in the neighborhood of one million pounds of lubricants per day.

The completion of the new warehouse now increases the company's total building facilities to over a quarter of a million square feet of covered work area. This new addition will permit the company to finish palletizing the entire material handling process. By palletizing the entire operation, handling costs will be substantially reduced. It will also enable the production departments to more efficiently handle the large volume of lubricants flowing through the plant on a day-to-day basis.

Mr. Mayor then mentioned the other part of the building expansion accomplishment—the addition of 5,000 sq. ft. of new office facility. This will increase the total office accommodations to over 10,000 sq. ft. The new construction was built adjacent to and tied in with the older office building which was built in 1946. The additional office facility will house the consolidated function of sales and services in addition to ground floor accommodations for Southwest's new IBM installation. The new building will also house elements of the financial division in addition to a new direc-

tor's room and several executive offices.

A former member of the NLGI Board of Directors, Mayor was succeeded by his son... H. A. "Sonny" Mayor, Jr. in 1953, who is presently concluding his year as 27th president of the Institute. M. L. Carter, vice-president of research and control, is a vice-chairman of the NLGI Technical committee.

Witco Chemical Buys Sonneborn Chemical

Witco Chemical Co., Inc., has acquired 100 per cent interest in Sonneborn Chemical & Refining Corp. and its subsidiaries in exchange for 300,000 shares of Witco stock, according to a joint announcement.

Sonneborn, privately owned, makes solvents, lubricating oils and other petroleum specialties. It reported sales of $37,478,000 and earnings of $858,000 for the fiscal year ended January 31.

Sonneborn will become a wholly-owned subsidiary of Witco. Three Sonneborn officials—R. G. Sonneborn, president; Gustave Schindler, vice-president, and Dr. Henry Sonneborn III, vice-president and secretary—were elected to Witco's board of directors.

New Engine-Testing Lab Slated by Socony

Plans to build a large new engine-testing laboratory as part of an accelerated program to develop fuels and lubricants for engines of the future have been announced by Socony Mobil Oil Co., Inc.

The facility, to be built at the company's research laboratories at Paulsboro, N. J., will nearly double Mobil's engine-testing capacity. The new lab will accommodate up to 20 test engines, ranging from giant marine and railway diesels to gas turbines, truck and passenger car engines.

It will enable Mobil's scientists to anticipate the fuel and lubricant needs of advanced engine designs years ahead of their commercial production.

Iron & Steel Convention, Exposition This Month

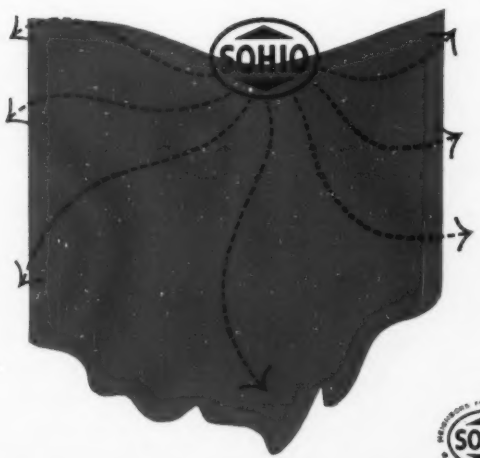
New lubricants and lubrication techniques will be subjects for a technical session this September at the 1960 Iron & Steel convention and exposition.

To be held in Cleveland auditorium, September 27 through 30, the event will include three technical papers on the subject, as well as exhibits by many leading manufacturers in the field.

New bulk grease handling systems will be one of the topics reviewed by representatives of U. S. Steel corporation, Revere Copper and Brass, Inc., and Morgan Construction company.

The session will include the following: "Test Stand Evaluation of Oil Film Roll Neck Bearings" by

Sohio brings you the quality stock oils you need . . . when and where you need them!



You're assured of prompt delivery of stock oils when you make Sohio your source of supply. That's because of Sohio's complete distribution system that brings stock oils to you *on time,* anyplace in the Midwest. And Sohio offers a complete line of high quality, dependable stock oils—paraffin or solvent—to completely meet the needs of any compounder or grease maker. Contact us now.

SOHIO

MIDLAND BLDG., CLEVELAND 15, OHIO

Norman A. Wilson, manager of research, and Samuel S. Rickley, chief engineer, Morgoil bearing department, Morgan Construction company, Worchester, Mass.; "New Methods for Handling Grease" by Charles A. Bailey, lubrication engineer, National Tube division, and Donald R. McCaa, product manager, Standard Products department, American Bridge division, United States Steel corporation, Pittsburgh, Pa.; "Oil Mist Lubrication on Antifriction Back-up Roll Bearings" by C. W. Southerington, chief engineer, Dallas division, Revere Copper and Brass, Inc., Chicago.

Lincoln Opens Branch Office in Atlanta, Ga.

A new branch office and warehouse in Atlanta, Ga., has been established by Lincoln Engineering Company, St. Louis. John E. Renner, general sales manager, has announced that J. P. O'Donnell will direct the branch operation. In addition to warehousing for Lincoln products, the office will provide service facilities.

The new office will serve the Southeastern states of Georgia, Florida, North and South Carolina, Tennessee, Mississippi, Virginia and part of Louisiana. Its address is: Lincoln Engineering company (Atlanta), 1845 Marietta Blvd., N. W., Atlanta 18, Ga.

Lincoln manufactures lubrication equipment and air compressors for automotive, industrial and agricultural use and a line of ignition system testing equipment.

A History of Ashland

A new book described as a study in management has been written about the parent firm of NLGI Marketing member Valvoline Oil company. Entitled "Blazer and Ashland Oil," by Joseph L. Massie, it traces the success of Ashland Oil and Refining from its organization in 1924 by Paul G. Blazer, up to his retirement 33 years later as chairman of the board.

Author Massie stresses the flexibility which enabled Blazer to build Ashland, listing the unconventional and informal way he ran the company. He also notes the difficulty Blazer had in delegating authority as the firm evolved into a large corporation.

This illustration of the significant role of personality in business history may be purchased from the University of Kentucky press, Lexington, for five dollars.

Single-Unit Lubrication System Permits Easy, Fast Auto Grease Jobs

A single-fitting lubrication system that will permit motorists to have their cars greased while the gas tank is filled has been prototyped by Climax Molybdenum company, a division of American Metal Climax, Inc., with the cooperation of the Farval company of Cleveland – two NLGI Associate members.

Important advantages of the system for the oil and automobile industries as well as the motorist were indicated in the announcement of the development.

A working prototype of this one-unit system, which is comprised of a single grease fitting mounted under the hood near the radiator cap and connected by nylon hoses to all lubrication points, has been installed in a late model car for testing. Preliminary trials have met with success.

By this unique method of applying chassis lubrication, grease is pumped through the master fitting to all necessary parts of the steering and front-end assemblies in a single, one-minute operation. According to E. E. Smith, manager of the chemical division for Climax and proponent of the single-fitting idea, use of this system would not only give the motorist added convenience but would expand the market for chassis grease and provide automobile producers with an attractive sales feature.

"With this system, the motorist would no longer have to give up his car for half a day or more to get a grease job," Mr. Smith explained. "As a result, he would be more inclined to have his car lubricated frequently, and the service station operator, no longer faced with scheduling difficulties and substantial labor costs, would be more likely to promote more lubrication."

In addition, Mr. Smith stated, the

Continued on page 236

QUALITY LUBRICANTS

INDUSTRIAL
AND
AUTOMOTIVE

Manufactured for

REFINERS
COMPOUNDERS
JOBBERS

FISKE BROTHERS REFINING CO.

PLANTS
Newark, N. J. Toledo, Ohio

The C. W. Nofsinger Company

CONSULTING ENGINEERS

Grease Plants
Petroleum Refineries
Petrochemicals

"In Engineering It's the People That Count"

307 East 63rd Street
Kansas City 13, Missouri

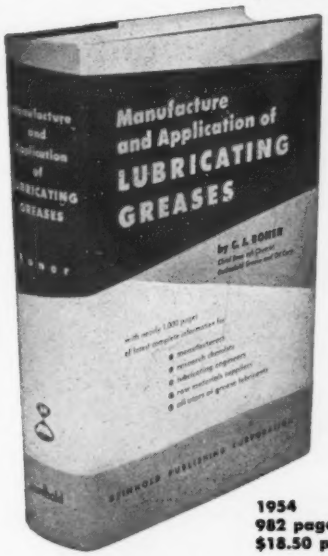
Available!

Manufacture and Application of

LUBRICATING GREASES

by C. J. Boner

Chief Research Chemist
Battenfeld Grease and Oil Corp.



1954
982 pages
$18.50 prepaid

982
FACT-FILLED PAGES
IN THESE
23
BIG CHAPTERS

1 Introduction
2 Structures and Theory
3 Additives Other Than Structural Modifiers
4 Raw Materials
5 Manufacturing Processes
6 Equipment for Lubricating Grease Manufacture
7 Aluminum Base Lubricating Greases
8 Barium Base Lubricating Greases
9 Calcium Base Lubricating Greases
10 Lithium Base Lubricating Greases
11 Sodium Base Lubricating Greases
12 Lead Soap Lubricating Greases
13 Strontium Base Lubricating Greases
14 Miscellaneous Metal Soaps as Components of Lubricating Greases
15 Mixed Base Lubricating Greases
16 Complex Soap Lubricating Greases
17 Non-Soap Thickeners for Lubricating Fluids
18 Fillers in Lubricating Greases and Solid Lubricants
19 Residua and Petrolatums as Lubricants
20 Analysis of Lubricating Greases
21 Tests of Lubricating Greases and Their Significance
22 Application of Lubricating Greases
23 Trends in Lubricating Greases

Here in one giant volume . . . the most complete storehouse of information ever published on the composition, properties and uses of lubricating greases!

The book begins by describing in detail the structure and theory of lubricating greases. Then follow chapters on the various raw materials, processes and manufacturing equipment. Lubricants containing specific thickeners, including such recent developments as lithium soaps, complex soaps and non-soap gelling agents, receive special attention.

Of major interest is the large section on present uses and future trends of lubricating grease products. Here you'll find the complete details of when, where, and how to apply a specific lubricant for any given purpose.

Everyone concerned with the preparation or use of grease lubricants will find Boner's book of enormous practical value. Manufacturers and lubricating engineers will find here a complete breakdown of the effects of each ingredient of treatment upon the characteristics of the final product, and a full explanation of the physical and chemical methods used in measuring these characteristics. Suppliers of fats, oils, additives, thickeners and other raw materials will gain new ideas for future product research and development. In addition, users of grease products will learn the properties of available lubricants and the major purposes that each fulfills.

MAIL THIS HANDY ORDER COUPON TODAY!

NLGI SPOKESMAN
4638 J. C. Nichols Parkway
Kansas City 12, Missouri

Please rush me a copy of Boner's MANUFACTURE AND APPLICATION OF LUBRICATING GREASES.

☐ I am enclosing $18.50
☐ Company Purchase Order

NAME_____

ADDRESS_____

_____

CITY & ZONE_____ STATE_____

automobile companies would be able to feature the advantages of speedy lubrication in their new models at a fraction of the cost involved in developing and producing greaseless cars which have been under consideration as a means of providing more motorist convenience.

Says Smith, who is following up his suggestion to the industry published earlier in the NLGI SPOKESMAN, "The principle of this one-fitting grease system could be applied to motor oil as well. The method of replacing crankcase oil could be improved, I believe, by installing a fitting on the engine block which would connect by tube to the bottom of the crankcase. In one brief step the used oil could be withdrawn by suction pump and in another, fresh oil added by the usual method."

New Name for ADM Manufacturing Operation

Industrial chemicals division is the new name of Archer-Daniels-Midland company's chemical products manufacturing operations.

Dr. George K. Nelson, division manager, said the change was made to describe more fully ADM's increasing emphasis on development, production and marketing of chemical intermediates for industry.

The industrial chemicals division produces and markets Hydrofol fatty acids and glycerides, Adol fatty alcohols, Adogen fatty nitrogen compounds and vegetable fatty acids for a variety of uses, including paints, soaps, printing inks, rubber, lubricants, textiles, leather, cosmetics and detergents. A number of specialty chemicals also are produced and new ones being developed in answer to the requirements of industry.

The division also manufactures and markets ADM's line of Admex vinyl plasticizers and refines and processes marine oils.

ADM recently announced that the industrial chemicals division will construct a multi-million dollar chemical center at Peoria, Illinois. The company presently operates chemical plants at Wyandotte, Mich.; Newark, and Elizabeth, N. J.; Minneapolis, Minn.; Ashtabula, Ohio, and Decatur, Ill.

New Lubricant Container Stores and Protects Own Applicator Brush

Contamination of greases and grease-applying brushes with dirt and other abrasive materials is a common problem in the lubrication of precision mechanical parts. To help eliminate this problem, the Alpha - Molykote corporation has developed a special plastic jar with an applicator brush for Molykote G, its widely-used extreme pressure lubricant. A protected well in the center of the jar stores the brush free from possible contaminants when the cap is replaced.

Of oil-resistant molded plastic, the jar contains a supply of Molykote G lubricant in the ring section surrounding the brush storage well. A synthetic rubber washer seals the jar proper when the cap is replaced, and a concentric fiber washer prevents the grease from entering the brush storage well. Thus the closed jar may be carried in any position without danger of leakage or brush contamination.

The brush is securely attached to the cap, which serves as a convenient brush handle. Thus, there is no need for hands to contact the grease and the convenience of the integral brush storage well should discourage laying it down on dirty benches or other contaminated surfaces. The aluminum brush ferrule can be removed for cleaning the bristles if necessary.

Applicator jars containing 10-oz. of Molykote G are currently available. The lubricant is highly recommended for threaded connections, press fittings, splines, highly loaded gears, taper sleeves, machinery wear-in, power screws, machine tool ways and guides, lathe centers and steady rests, chucks and collets and hundreds of other tough friction and wear problems.

Houghton Opens New West Coast Plant

To handle its increasing west coast business, E. F. Houghton & Co. has opened a new plant at 54 Tanforan Ave., South San Francisco. Industrial oils and chemicals formerly manufactured at Houghton's plant at 1500 Davidson Ave., San Francisco, are now being supplied from the new facility.

Equipment newly installed includes provision for sulphonation, saponification, compounding, esterification and condensation reactions. Capacity has been increased more than 50 per cent over the former plant.

The new plant is located on a three-acre plot and includes 30,000 sq. ft. of manufacturing space, a new office building, control laboratory and 10,000 sq. ft. of outdoor storage area.

Houghton serves west coast in-

LUBRICATING GREASES • METALWORKING LUBRICANTS • SPECIAL PROCESS OILS
BEMOL
BEMOLybdenum Fortified Lubricants
Never Underestimate the Importance of Protective Lubrication
mbi
ON GUARD SINCE 1888
MAGIE BROS. OIL CO.
Franklin Park, Illinois • Chicago Phone TU 9-4800

dustry from southern California where it maintains a warehouse in Los Angeles, and throughout the bay area, and north to Portland, Seattle and Vancouver. Its staff of technically trained field representatives is under the direction of John Bermingham, western sales manager. The plant manager is A. S. Horwitz.

Metalworking items and functional fluids such as cutting and quenching oils, rust preventives, metal cleaners, specialty lubricants, hydraulic fluids and packings are included in the product line, these being supplied from five other plants over the country: Philadelphia, Chicago, Detroit, Carrollton, Ga., and Toronto, Canada. The company was started in 1865 in Philadelphia, and is well known for its unique industrial house organ—*The Houghton Line*, which is over 50 years old.

Dispersion of Colloidal Molybdenum Disulfide In Isopropyl Alcohol

Introduction of a highly stable, concentrated dispersion of colloidal molybdenum disulfide in isopropyl alcohol, designated 'dag' Dispersion No. 210, has been developed by Acheson Colloids Co., a division of Acheson Industries, Inc.

When diluted with compatible diluents to the most satisfactory solids content 'dag' 210 forms a tightly adherent film which is applicable to a variety of substrate materials with minimum, if any, surface pretreatment.

The 'dag' 210 can be applied by spray, brush, dip or swab. The resultant fast-drying, film exhibits the unique high-pressure, high-temperature lubricating and release properties inherent with molybdenum disulfide.

Processed from specially refined MoS_2, 'dag' 210 resists settling to ensure optimum stability and maximum shelf life.

Typical applications of the product include assembly and run-in lubrication, maintenance lubrication, wire drawing lubrication, gasket coating, stop-off coating and mold release.

For further information and a complimentary sample of 'dag' Dispersion No. 210, write Acheson Colloids Co., Port Huron, Mich.

Automotive Lubrication Service Guide Offered

The publication of the new 1960 Automotive Lubrication Service Guide has been announced by the Chek-Chart corporation.

In its more than 160 pages, the 1960 Guide contains complete lubrication information, including:

A complete service instruction section containing full "How-To-Do-It" procedures. This section also includes two tabular pages of complete automatic transmission fluid level checking and drain and refill service information.

Lubrication diagrams on all the 1960 car models including the new "Compacts", plus revised diagrams on older passenger cars. Popular light truck diagrams are also included.

Lubrication diagrams covering 24 makes of the most popular imported cars. This is coverage for over 82 per cent of the total registration of these cars.

Four tabular charts containing the lubricant recommendations and capacities of the crankcase, transmission, and differentials for practically all the imported passenger cars.

Contact positions on the diagrams show where lift adapters must contact cars with wide frames, X-frames, or unitized bodies when using frame engaging lifts.

Frame engaging lift instructions and wheel spotting position charts.

Complete identification information on limited-slip type differentials is included on all applicable diagrams.

Also contained on each applicable page is the automatic transmission fluid level checking procedure.

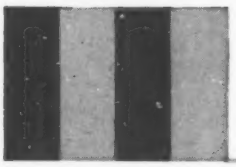
Table of capacities provides complete refill capacities of crankcase, transmission, differential, cooling system, and gas tank. Tire pressure table lists the recommended cold pressures for all tire sizes of car models covered on the diagram.

This complete range of information makes the 1960 Automotive Lubrication Service Guide the stationman's one-volume lubrication service reference.

Further information and prices on request.

DEEP ROCK
Superior Specifications
CYLINDER STOCKS
Fine Lubricating Qualities For Greases and Fluid Lubricants
Kerr-McGee Oil Industries, Inc.
Kerr-McGee Building
Oklahoma City, Okla.
CE 6-1313

SIGN OF
CORRECT LUBRICATION
Mobil
Makers and Marketers of
Mobil Automotive
Products
Mobil Industrial
Oils and Greases
150 E. 42nd STREET
NEW YORK 17, N. Y.



NLGI Associate, Technical

CONTAINER AND CLOSURE MANUFACTURERS

American Can Company
4810 Belleview, Kansas City 12, Mo.
Representative—H. T. Rich

American Flange & Manufacturing Company, Inc.
30 Rockefeller Plaza, New York 20, N. Y.
Representative—Richard L. Parish, Jr.

Bennett Industries
Peotone, Illinois
Representative—S. A. Bennett

Central Can Company, Inc.
3200 South Kilbourn Ave., Chicago 23, Ill.
Representative—Henry Frazin

Cleveland Container Company
4925 So. Halsted St., Chicago 9, Ill.
Representative—R. D. Sayles

Continental Can Company, Inc.
100 East 42nd St., New York 17, N. Y.
Representative—W. J. Flint

Geuder, Paeschke & Frey Company
324 North Fifteenth St., Milwaukee 1, Wis.
Representative—Neil Savee

Greif Brothers Cooperage Corp.
1821 University Ave., St. Paul 4, Minn.
Representative—Ray Suttle

Inland Steel Container Company
6532 South Menard Ave., Chicago 38, Ill.
Representative—J. Daniel Ray

Jones & Laughlin Steel Corporation
Container Division
3 Gateway Center, Pittsburgh 30, Pa.
Representative—J. E. Morris

National Steel Container Corp.
6700 South LeClaire Ave., Chicago 38, Ill.
Representative—Henry Rudy

The Ohio Corrugating Company
917 Roanoke Ave. S. E., Warren, Ohio
Representative—Lawrence F. McKay

Republic Steel Corporation
Container Division
465 Walnut Street, Niles, Ohio
Representative—Theodore Humphrey

Rheem Manufacturing Company
400 Park Ave., New York 22, N. Y.
Representative—G. Gwyn Tucker

Rieke Metal Products Corporation
Auburn, Indiana
Representative—Raymond F. Ouer

Sefton Fibre Can Company
Div. Container Corp. of America
3275 Big Bend Blvd., St. Louis, Mo.
Representative—W. V. Swofford

Steel Package Division of National Lead Company
722 Chestnut Street, St. Louis 1, Mo.
Representative—Warren T. Trask

United States Steel Products
Division, United States Steel Corporation
30 Rockefeller Plaza, New York 20, N. Y.
Representative—C. R. Justice

Vulcan-Associated Container Companies, Inc.
P. O. Box 161, Bellwood, Ill.
Representative—V. I. McCarthy, Jr.

ENGINEERING SERVICES

The C. W. Nofsinger Company
307 East 63rd Street, Kansas City 13, Mo.
Representative—C. W. Nofsinger

Sumner Sollitt Co.
307 N. Michigan Ave., Chicago 1, Ill.
Representative—A. J. Barth

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

Balcrank, Inc.
Disney near Marburg, Cincinnati 9, Ohio
Representative—Richard P. Field

The Farval Division Eaton Manufacturing Co.
3249 East 80th St., Cleveland, Ohio
Representative—Lee Witzenburg

Gray Company, Inc.
60 Northeast 11th Ave., Minneapolis 13, Minn.
Representative—B. A. Beaver

Lincoln Engineering Division McNeil Machine & Engineering Co.
4010 Goodfellow Ave., St. Louis 20, Mo.
Representative—R. E. Crean

Stewart-Warner Corporation
Alemite Division
1826 Diversey Parkway, Chicago 14, Ill.
Representative—E. G. Wicklatz

MARKETING ORGANIZATIONS

Ampol Petroleum, Ltd.
Buchanan Street
Balmain, New South Wales, Australia
Representative—M. E. Brownell

California-Texas Oil Company
380 Madison Ave., New York 17, N. Y.
Representative—Hal U. Fisher

Canadian Petrofina Limited
505 Dorchester Street West
Montreal, Quebec, Canada
Representative—M. E. Wight

Cooperative GLF Exchange, Inc.
Terrace Hill, Ithaca, N. Y.
Representative—W. S. Miller

Denco Petroleum Company
5115 Denison Avenue, Cleveland 2, Ohio
Representative—I. L. Carmichael

Derby Refining Co.
420 West Douglas, Wichita, Kan.
Representative—W. B. Neil

D-X Sunray Oil Company
Mid-Continent Bldg., P. O. Box 381, Tulsa, Okla.
Representative—J. W. Basore

Farmer's Union Central Exch., Inc.
P. O. Box G, St. Paul 1, Minn.
Representative—H. F. Wagner

Illinois Farm Supply Company
P. O. Box 585, Bloomington, Ill.
Representative—S. F. Graham

Lubrication Engineers, Inc.
P. O. Box 7128, Fort Worth 11, Texas
Representative—James P. Bell

Ohio Farm Bureau Cooperative Association, Inc.
245 North High Street, Columbus 16, Ohio
Representative—Walter N. Callahan

Pennsylvania Refining Company
2686 Lisbon Road, Cleveland 4, Ohio
Representative—Ben Sollitto

United Co-Operatives, Inc.
111 Glamorgan, Alliance, Ohio
Representative—A. J. Miller

Valvoline Oil Company
Division of Ashland Oil & Refining Co.
Box G, Freedom, Penna.
Representative—D. A. Smith

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

Barrett Manufacturing Company
P. O. Box 8096, Houston 4, Texas
Representative—George J. Barrett, Jr.

and Marketing Members

Chemicolloid Laboratories, Inc.
55 Herricks Road, Garden City Park, N. Y.
Representative—David F. O'Keefe

Girdler Process Equipment Division, Chemetron Corp.
P. O. Box 43, Louisville 1, Ky.
Representative—J. E. Slaughter, Jr.

Manton-Gaulin Mfg. Co., Inc.
44 Garden Street, Everett 49, Mass.
Representative—J. J. Dwyer

Stratford Engineering Corporation
612 W. 47th Street, Kansas City 12, Mo.
Representative—D. H. Putney

Struthers Wells Corp.
1003 Pennsylvania Ave. West, Warren, Pa.
Representative—K. G. Timm

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

American Potash & Chemical Corp.
99 Park Avenue, New York 16, N. Y.
Representative—W. F. O'Brien

Archer-Daniels-Midland Company
Industrial Chemicals Division
P. O. Box 532, Minneapolis 40, Minn.
Representative—J. H. Kane

The Baker Castor Oil Company
40 Avenue A, Bayonne, N. J.
Representative—J. W. Hayes

Baroid Chemicals, Inc.
A subsidiary of National Lead Company
1809 South Coast Life Building
Houston 2, Texas
Representative—Mr. C. M. Finlayson

Godfrey L. Cabot, Inc.
141 W. Jackson Blvd., Chicago, Ill.
Representative—Warren M. Parsons

Climax Molybdenum Company
1270 Avenue of the Americas, New York 20, N. Y.
Representative—K. B. Wood, Jr.

Darling & Company
4201 South Ashland Ave., Chicago 9, Ill.
Representative—L. Strauf

E. I. du Pont de Nemours & Company, Inc.
Wilmington 98, Delaware
Representative—Joseph J. Mikita

The Elco Lubricant Corporation
Jennings Road & Denison Avenue
Cleveland 9, Ohio
Representative—R. K. Smith

Emery Industries, Inc.
4300 Carew Tower, Cincinnati 2, Ohio
Representative—G. W. Boyd

Enjay Chemical Company
Div., Humble Oil & Refining Co.
15 West 51st St., New York 19, N. Y.
Representative—Warren C. Wilson

Foote Mineral Company
18 W. Chelten Ave., Philadelphia 44, Penna.
Representative—W. M. Raynor

A. Gross and Company
295 Madison Avenue, New York 17, N. Y.
Representative—Eugene W. Adams

Harchem Division Wallace & Tiernan, Inc.
25 Main St., Belleville, N. J.
Representative—H. M. Abbott

Humko—Chemical Department
P. O. Box 398, Memphis 7, Tenn.
Representative—W. J. O'Connell

Lithium Corporation of America, Inc.
Rand Tower, Minneapolis 2, Minn.
Representative—Malcolm M. Moore

The Lubrizol Corporation
Box 3057—Euclid Station, Cleveland 17, Ohio
Representative—J. B. Irwin

Mallinckrodt Chemical Works
2nd & Mallinckrodt Sts., St. Louis 7, Mo.
Representative—D. B. Batchelor

The McGean Chemical Co.
Midland Building, 101 Prospect Ave., N. W.
Cleveland 15, Ohio
Representative—W. A. Ritchie

Metasap Chemical Division Nopco Chemical Company
60 Park Place, Newark, N. J.
Representative—T. J. Campbell

Monsanto Chemical Company
800 North Lindbergh Blvd., St. Louis 66, Mo.
Representative—J. W. Newcombe

Newridge Chemical Company
7025 West 66th Place, Chicago 38, Ill.
Representative—T. E. Shine

M. W. Parsons—Plymouth, Inc.
59 Beekman St., New York City 38, N. Y.
Representative—Herbert Bye

Werner G. Smith, Inc.
1730 Train Avenue, Cleveland 13, Ohio
Representative—W. Meckes, Jr.

Swift & Company
165th & Indianapolis Blvd., Hammond, Ind.
Representative—F. H. Beneker

Synthetic Products Company
1636 Wayside Rd., Cleveland 12, Ohio
Representative—Garry B. Curtiss

Witco Chemical Company
122 East 42nd St., New York 17, N. Y.
Representative—H. R. Spielman

TECHNICAL AND RESEARCH ORGANIZATIONS

Battelle Memorial Institute
505 King Avenue, Columbus 1, Ohio
Representative—S. L. Cosgrove

The Chek-Chart Corporation
33 East Congress Parkway, Chicago 5, Ill.
Representative—H. Eldridge

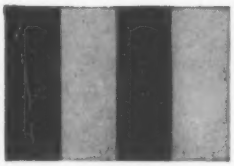
Chemico (Pty.) Ltd.
Miller and 7th Streets, P. O. Box 6349,
New Doornfontein, Johannesburg,
South Africa
Representative—O. Richter

Compagnie Francaise de Raffinage Direction Recherches et Procedes
22, Rue Boileau, Paris (16e) France
Representative—Albert E. Miller

Institut Francais du Petrole
CMrR—Courtel, 4 Place Bir Hackeim
Rueil—Malmaison (S. et Oise) France

LABOFINA S. A. Centre de Recherches du Groupe PETROFINA
98/100 Chaussee de Vilvorde,
Bruxelles (N.O.H.), Belgium
Representative—R. Gillerot

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill.
Representative—Mrs. G. A. Krawetz



People in the Industry

M. R. Swain Named Rheem Vice-President

M. R. Swain has been appointed vice-president of Rheem Manufacturing company, A. Lightfoot Walker, president, has announced. Mr. Swain will serve as coordinator of international affairs of the company, which through subsidiary and associated companies operates 32 plants in sixteen countries abroad. There are twenty Rheem plants in the United States.

Since 1951 Mr. Swain has been chairman and managing director of Hume Industries, Singapore, and managing director of Rheem Hume (Far East) Ltd., Rheem subsidiary in Singapore. He has also served as chairman of Rheem Hume since 1957.

HARSHAW LEAD BASE

Harshaw Lead Base, as an additive to petroleum lubricants, improves extreme pressure characteristics and imparts the following desirable properties:

- Increased film strength
- Increased lubricity
- Improved wetting of metal surfaces
- A strong bond between lubricant and metal surfaces
- Resistance to welding of metals at high temperatures
- Moisture resistance and inhibits corrosion

Harshaw Lead Bases are offered in three concentrations to suit your particular needs:

Liquid 30% Pb	Liquid 33% Pb	Solid 36% Pb

Other metallic soaps made to your specifications. Our Technical Staffs are available to help you adapt these products to your specific needs.

THE HARSHAW CHEMICAL CO.
1945 E. 97th Street • Cleveland 6, Ohio
Branches In Principal Cities

To Represent Jesco in Texas

Jim Jelley, a resident of Houston, Texas, joins Jesco Lubricants Co. as their representative for Texas and the surrounding territory.

Mr. Jelley is a native Texan and has been a resident of Houston for over twenty years. He is a qualified lubrication engineer and has a wide acquaintance with Texas industries.

R. A. Hagberg Joins Capital City Products

The Capital City Products company of Columbus, Ohio announced that Ralph A. Hagberg has joined their organization as sales manager of the fatty acid division.

Mr. Hagberg has served over twenty years in the chemical industry and has had many years of research, marketing, technical service, and sales experience in oils, fats, fatty acids and their derivatives. His sales experience is diversified in that he has sold directly for manufacturers and also as a manufacturer's representative.

He has published a number of articles on vegetable oil refining. During World War II he served in the Army as a major.

Change at Harchem

Wallace E. Riffelmacher, of the Harchem division of Wallace & Tiernan Inc., has been transferred from the sales department to the product development department to assist Bill Wiley, product development manager, in the introduction of new plasticizers, dimer acids and epoxy additives.

Two Changes At Southwest

Two changes have been announced by H. A. Mayor, president of Southwest Grease and Oil of Wichita. Carl E. Bryan has been promoted from chief accountant to assistant controller, where he will head up credit and billing functions, in addition to assisting the controller's office in corporate financial matters.

Replacing Bryan as chief accountant is C. Dale Treat. He was recently employed by Southwest and was formerly employed by a local oil equipment manufacturing concern.

Warren Appoints R. B. Worley

Robert B. Worley has been appointed vice-president, lubricating sales, of the Warren Refining and Chemical Co., Cleveland, Ohio, according to an announcement by Ian L. Carmichael, Warren president.

Mr. Worley's career with Warren began in 1942, after six years as a sales engineer with Lubrizol Corp., also of Cleveland. Mr. Worley became sales manager of Warren in 1949.

Inland Steel Container Appoints Two Managers

Inland Steel Container company, drum and pail manufacturing division of Inland Steel company, has appointed Clarence E. Johnson, Jr., manager of its Chicago plant, and Donald E. Malcolm, manager of industrial engineering for all its plants. Johnson was formerly general manager of Plasti Products, Inc., Winona, Minn. Malcolm was formerly with Standard Products company in Cleveland.

THE CASE FOR LITHIUM: **IONIC SIZE**

Pauling's formulation of univalent crystal radii indicates that the lithium ion is indeed the smallest alkali metal ion.

ATOMIC AND IONIC RADII OF ALKALI METALS (PAULING)

	Li	Na	K	Rb	Cs
M (Angstroms)	1.225	1.572	2.025	2.16	2.35
M+(Angstroms)	0.60	0.95	1.330	1.48	1.69

Lithium's small ionic radius permits shorter internuclear distances between cation and anion. Thus, the lattice or crystal energies of lithium salts should be higher than those of other alkali metal salts. An analysis based on the Born-Haber cycle readily shows this to be true.

The heats of formation of large anion lithium compounds are usually lower than other alkali metal compounds due to lithium metal's high ionization potential and heat of sublimation. But this is not true for small anion lithium compounds. LiF, Li_2O, LiH, Li_2C_2, Li_2S, and Li_3N are all more stable than their other alkali metal congeners. And the freedom with which lithium combines with small anions may well be responsible for its excellent performance in metal scavenging and degassing.

IONIC POTENTIAL The concept of ionic potential (ionic charge/ionic radius) successfully relates the charge densities and deforming powers of the alkali metal ions. Lithium, of course, has the highest ionic potential of the alkali metals, and therefore, the highest free energy of hydration. And a modified Born-Haber cycle shows that lithium in aqueous systems matches cesium as the strongest reducing agent of the alkali metals.

SOLVATION ENERGY High ionic potential is also responsible for the unusual solubility behaviors of ionic lithium compounds. Lithium's high solvation energy favors breakdown of the ionic crystal lattice by solvent-ion interaction. Thus, the utility of LiH and $LiAlH_4$ as reducing agents. Unlike NaH and $NaAlH_4$, they are relatively soluble in diethyl ether, a desirable medium.

One indication of the extensive solvent-ion interaction suggested is the high hydration energy of the lithium ion . . . leading to an increase in lithium ion size in solution. The size increase is due to an adhering sheath of solvent molecules or dipoles. Thus, the lithium ion, smallest of the alkali metal ions in the solid state, is the largest in solution in water.

IONIZATION POTENTIAL AND RELATED PROPERTIES OF THE ALKALI METALS

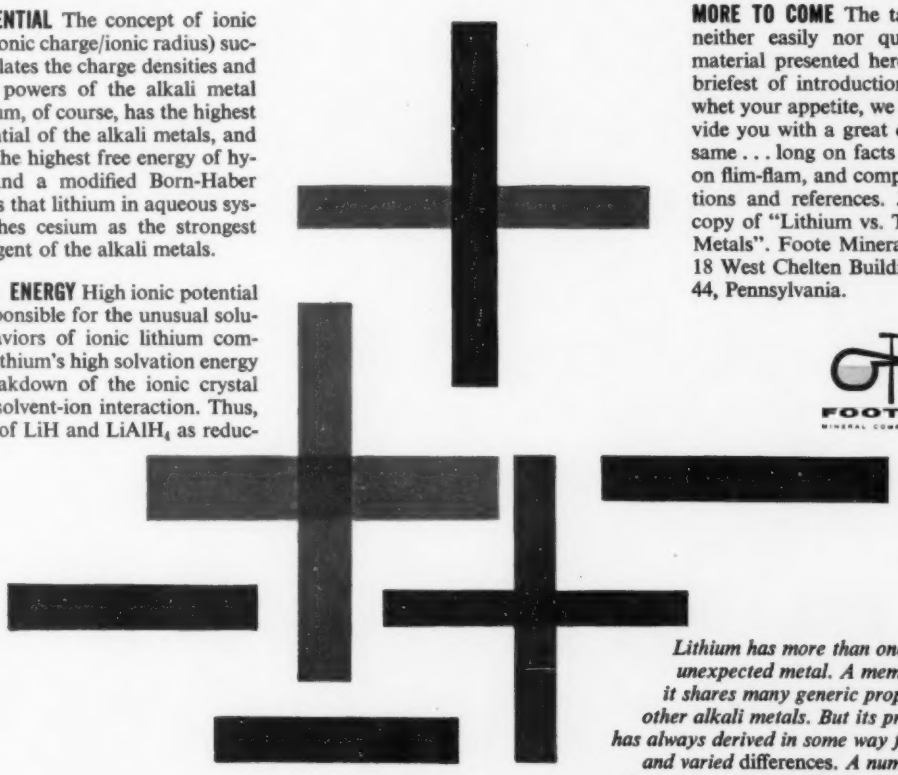
	Li	Na	K	Rb	Cs
Ionization Potential (electron volts)	5.390	5.138	4.339	4.176	3.893
Oxidation Potential (E_o at 25°C, volts)	3.02	2.71	2.92	2.99	3.02
Heat of sublimation (kcal, 25°C)	36.44	25.95	21.52	20.50	18.83
Heat of Hydration of Gaseous Ion (kcal/mole)	123	97	77	70	63

The lithium ion—water dipole aggregates are probably responsible for the severely negative deviations from ideal solution behavior exhibited by lithium salts in solution. Lithium salts yield solutions with abnormally low colligative properties . . . very low aqueous vapor pressures, very low freezing points, etc. . . . as well as the highest stoichiometric activity coefficients of all the alkali metals. For equivalent molar concentrations of alkali metal salts, lithium salts have the highest effective thermodynamic concentrations, the basis for the superior performance of lithium bromide solutions in absorption refrigeration, and of lithium chloride solutions in humidity control equipment.

BOND CHEMISTRY With the highest electronegativity of the alkali metals, lithium has the greatest tendency to form covalent or mixed covalent bond types. Thus, lithium alkyls tend to be much more covalent than corresponding sodium alkyls, and as a result are far more soluble in non-polar solvents. But there is still sufficient polar or ionic character to the lithium-carbanion bond to exert an orienting force on such reactions as the stereospecific polymerization of isoprene.

MORE TO COME The tale of lithium is neither easily nor quickly told. The material presented here constitutes the briefest of introductions. But if it has whet your appetite, we can happily provide you with a great deal more of the same . . . long on facts and ideas, short on flim-flam, and complete with derivations and references. Just write for a copy of "Lithium vs. The Other Alkali Metals". Foote Mineral Company, 402 18 West Chelten Building, Philadelphia 44, Pennsylvania.

FOOTE
MINERAL COMPANY

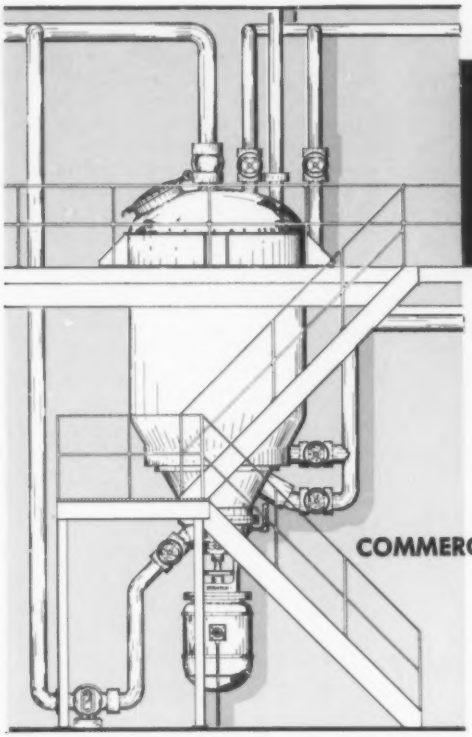


Lithium has more than once been called the unexpected metal. A member of Group IA, it shares many generic properties with the other alkali metals. But its primary usefulness has always derived in some way from its many and varied differences. A number of the more interesting of these differences are discussed here, all of them related to the fact that, under varying circumstances, lithium has at once both the smallest and the largest of the alkali metal ions

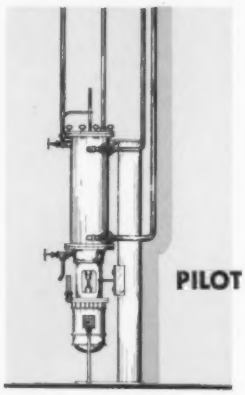
STRATCO

GREASE CONTACTORS

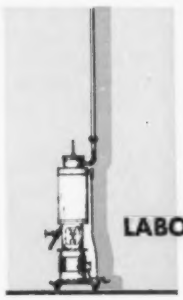
- **Simplify Production**
- **Reduce Costs**
- **Produce More Uniform Greases**



COMMERCIAL



PILOT



LABORATORY

Used in a complete Stratco Installation or as units in existing plants, Stratco Contactors provide continuous or batch mixing with very short time cycles, less soap, less laboratory control.

They replace other less efficient equipment, simplify plant layout, make possible either increased production or fewer man hours of operation.

Available in three types as illustrated so experimental and pilot plant results can be used for the formulation and plant guidance of full scale commercial equipment. Intermediate sizes to meet all requirements. Write for details.

STRATFORD ENGINEERING CORPORATION • **PETROLEUM REFINING ENGINEERS**

612 West 47th St. Kansas City 12, Mo.

REPRESENTATIVES

D. D. Foster Co., Pittsburgh, Pa.
D. D. Foster Co., S. Charleston, W. Va.

Lester Oberholtz, Los Angeles
Rawson-Houlihan Co., Inc., Houston
Rawson-Houlihan Co., Inc., Beaumont, Texas

The Rawson Co., Inc., Baton Rouge
F. J. McConnell Co., New York

C960